Adult mathematics students: reflections on their learning

Thesis

Adult Mathematics Students: reflections on their learning

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ABSTRACT

The experiences and conceptions of learning of five Open University adult students are reported and explored in this study. The students were studying *Open Mathematics*, a first level 30 point supported distance-learning course. The course included activities designed to encourage active and reflective learning.

A phenomenographic approach was used to capture a variety of students' conceptions of learning, including their awareness of their own learning (metacognition). I interviewed each student individually three times, twice during the year of the course and again one year later. I asked the students to think about their learning in a reflective way and to report on any changes in their learning.

This study found that the students tended to separate the mathematical activities from the 'learning to learn' activities, sometimes resisting or even deliberately avoiding the latter. However a variety of issues was raised and explored, such as the different kinds of writing required by this course and the uses and meanings of the language of learning. Other issues included barriers to learning, problems of finding time for study and the difference between distance-learning and face-to-face study.

With such a small number of students, generalisations were not possible or even aimed for. Instead the study shows a wide range of different experiences and preconceptions of learning and describes changes in learning made by the students during the course.

ACKNOWLEDGEMENTS

I am greatly indebted to my four supervisors for all the help and support they have given me. Christine Shiu and Michelle Selinger were there at the start and Eric Love took over from Michelle when she moved to another post. Soon after the data had been collected and in the middle of the analysis Christine died suddenly. There followed a time of grieving for a person for whom I had great respect and who was so interested in the work I was doing. After adjusting to this situation I returned to the study when Eric was joined by John Mason and together they supervised the later stages.

I am very grateful to Jane Williams for her help at the start of the study in agreeing access to students. Hilary Holmes and Lucy Champion have been of great help too at various stages of the study. I thank all the students who were interviewed in the pilot and main studies for being so welcoming and willing to discuss their learning.

During lively discussions on train journeys from Birmingham to Milton Keynes Barbara Allen gave me valuable help in preparing for the third set of interviews. Peter Johnston-Wilder helped me sort out characteristics of methodology. My husband, Nicholas, has been a continual support and I have very much appreciated his help with the final copy editing, though of course I accept responsibility for any errors that remain.

I embarked on this research after being introduced to the Centre for Mathematics Education Research Days by Heather Cooke, a current colleague and also a past colleague in a previous post. I owe tremendous thanks to her for keeping me going and giving me encouragement at all times.

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INTRODUCTION

This introduction gives information on the background of this study and my reasons for embarking on it. The original research questions are listed at the end.

Background to study

To help set this study in context I start by giving some details of my experience in education both as a student and as a teacher. For most of my life I have been involved with learning and teaching but it is only in the later stages of my career that I have begun to think about my own learning and how I can help others to learn, especially by listening to those learners who are my students. My experience as a learner at school and as an undergraduate at a conventional university was largely about memorising and reproducing knowledge and techniques. With a brand new degree in Chemistry I went into secondary teaching where the emphasis again was on 'teaching' by transmission (Boaler 1997) rather than enabling students to learn so I paid little attention to my students' approaches to learning. Even when I studied for my Post Graduate Certificate in Education several years later the pedagogy of *teaching* my subject was stressed and I was unaware of issues such as students' perceptions of learning.

After several years as a teacher I decided to teach mathematics rather than science so to support this change I first took two Open University courses; M101 *Mathematics Foundation* and M203 *Introduction to Pure Mathematics*. Although I learned mathematical concepts and skills from these courses I did not begin to 'learn how to learn mathematics' until I took EM235 *Developing Mathematical Thinking* followed by E802 *Applied Studies in Mathematics Education*.

At about the same time I used the questionnaires suggested in *Girls into Mathematics* (The Open University/ILEA 1986) with groups of 13/14 year olds. This experience opened my eyes to the possibilities of finding out more about my students' attitudes, expectations and feelings about mathematics and they told me that this was the first time anyone had asked for their views on mathematics. They were keen to collect and analyse the data and compare the results for their group with those obtained by others. I found that the students' responses gave me more insight into their *feelings* about mathematics as a subject than information about their attitudes to learning. Later, as a result of a discussion with Christine Shiu at a Centre for Mathematics Education Research Day, I learned about the study *Awareness of Learning, Reflection and Transfer in School Mathematics* (Bell *et al.* 1993). I used some of their activities, designed to improve students' awareness of their own learning, with a Year 9 group (aged 13 and 14 years) as part of a small scale research project 'Improving Learning; Enhancing Achievement' run by my local LEA Inspector.

I also discovered the *'Maths Is . . ' Jugglers* series written for 11-14 year olds learning mathematics (Young and Hamilton 1993). The material in the booklets was designed to encourage students to take some responsibility for their own learning and make choices, such as how many examples they needed to do in an exercise and assessing their readiness to move on to the next topic. I decided to focus on one teaching group made up of about thirty students in Year 9 (13 and 14 years old) with a roughly equal number of boys and girls. In order to find out more about my pupils' learning in a more rigorous fashion I registered with a local Higher Education college for a research degree, with the broad research question: 'Does increased awareness of the learning process improve the student's learning?' However, soon after the initial planning I was encouraged to take early retirement to help solve financial problems in the school and found myself still with

research questions but no population to research and no opportunity to research my own practice.

With hindsight, at this point it might have been more sensible to drop any further ideas about doing formal research but at the time I thought that doing a research project would give some structure to my life. I withdrew from the course at the local CHE and registered with The Centre for Mathematics Education (CME) at The Open University where I had been attending occasional research seminars. After discussion with my new supervisors, Christine Shiu and Michelle Selinger, it was agreed that I should research adult students on *Open Mathematics* (MU120) a new entry level course which included activities designed to improve students learning. At the same time I was appointed an Associate Lecturer for the same course so became familiar with its content and approach.

I have had many roles in my long and varied involvement in education, first as a student at school and then at conventional Higher Education institutions at both undergraduate and post-graduate level. Since then I have studied part-time as a distance-learner with the Open University taking undergraduate mathematics courses, post-graduate mathematics education courses and now this Master of Philosophy research degree. In my professional career I have taught 11-18 year-olds in all types of secondary school, and worked for my LEA as an advisory teacher for mathematics and as a consultant for projects such as the provision for able pupils in secondary schools and mathematics in the workplace . Now I work as an Associate Lecturer for the Open University for Level 1 *Open Mathematics* and Level 0 *Openings* courses and in mathematics education as a part-time researcher and contributor to courses. One morning a week I work with 4 - 7 year olds and their parents or carers in Family Numeracy. Some of these many roles provide opportunities for the

resonance sections near the end of each of the five stories that make up the main body of this report.

In the next chapter I describe my journey through some of the literature relating to students' awareness of their own learning and reflective learning in particular but first I list the research questions with which I started this study.

Original Purpose and research questions:

The main purpose of this study was to find out more about the experiences of students as they studied *Open Mathematics* and in particular their awareness of their own learning. I expected this to inform me as a tutor on this course. The data for this study would come from interviews with a small number of *Open Mathematics* students (though not my own) with the main research questions:

1. To what extent are *Open Mathematics* students aware of their own learning?

2. Are *Open Mathematics* students aware of any changes in their learning during the course?

3. How do *Open Mathematics* students use the activities designed to help them learn how to learn?

4. Do *Open Mathematics* students use reflective type learning?

CHAPTER 1 LITERATURE REVIEW

This chapter starts with a review of literature about metacognition and students' awareness of their own learning as this informed me in the time leading up to this study. It moves on to look briefly at other issues of learning before reviewing literature related to learning issues for the first level Open University course *Open Mathematics*, the course being taken by the subjects of this study. Literature relating to research methodology is reviewed and used in the next chapter.

Awareness of own learning (Metacognition)

My interest in students' awareness of their own learning led me to the Australian Project for Enhanced Effective Learning, PEEL, (Baird and Northfield 1992). In this study a group of secondary school teachers used action research methods to try to improve the quality of their students' learning. The aims of the project included: fostering students' independent learning via enhanced metacognition; changing teachers' attitudes and behaviours to ones that promote such learning; and investigating the processes of teacher and student change. Their working definition of metacognition consisted of many parts such as knowledge about learning (e.g. nature of learning and effective techniques) and awareness of its purpose, nature and progress.

As a result of this research, Baird and Northfield (1992 p. 80), described the differences in beliefs of 'passive' and 'metacognitive' learners. Of the fourteen listed aspects, two of the metacognitive ones interested me most. The first was the belief that each student has a responsibility for his or her own learning and can influence it. The second was the importance of students retrieving and reflecting on their own views and contrasting them with those of other people. This PEEL project resonated with me when I was still teaching

mathematics in a secondary school giving me examples of teachers reflecting on their own practice and at the same time encouraging their students to reflect on their own learning. Here was something with which I could possibly compare my own experiences and views.

However, more relevant to my own situation was the work being carried out here in the UK at about the same time. Bell *et al.* (1993) studied awareness of learning and the use of metacognitive skills by secondary school students in mathematics. Working with a group of six teachers they introduced intervention activities in classrooms using a case study approach. The purpose of the activities was to enhance pupils' awareness of *what* they were learning and *how* they were learning. Specific activities introduced to the pupils included modifications to lesson material, keeping diaries, making up their own questions, reviewing materials and encouraging class discussions about misconceptions and errors. Each teacher involved in the study chose different activities so this made it difficult to make overall conclusions, though in general they found that students showed some improvement when they had experienced a range of activities designed to enhance awareness. Before the research study, Bell *et al.* had assumed that students would value any activity that stimulated reflection more than an activity that did not, but they found that this was not always the case. Those students who wanted to do well in examinations did not see the necessity for reflective activities to help them achieve good results and some students were resistant to changing their pre-existing ideas about learning.

The ideas and findings of these two studies were still relevant when I changed to researching the learning of adults but I had to widen my search of the literature and look in particular at the variety of learners' experiences. Research carried out from the learner's perspective includes conceptions about learning (Säljö 1997) and approaches to learning (Marton and Säljö 1997). Students' reasons for taking up study are discussed by Beaty,

Gibbs & Morgan (1997) who group learning orientations in four categories: vocational, academic, personal and social. Lockwood (1995) discusses the characteristics of Open University students who are 'TMA Dominated' and 'TMA Aware'. (Tutor Marked Assignments (TMAs) make up part of the continuous assessment component of Open University courses). His research into the way students perceive the benefits and costs of activities in self-instructional texts (such as those found in *Open Mathematics*) is particularly relevant to my study. The issues arising from research such as this are introduced at relevant points in subsequent chapters of this study.

Reflective learning

This section briefly reviews work done on reflective learning in order to lead into a discussion about the reflective learning activities in *Open Mathematics* and to support my research question 'Do *Open Mathematics* students use reflective type learning?'

As an Open University Associate Lecturer (Tutor) I have been given various staff development materials about reflective learning. One of the Open Teaching Toolkit series 'Learning how to Learn' (Coats 1991), uses a model based on the work of Boud, Keogh and Walker (1985) and suggests exercises that can be used in tutorials to help reflective learning. Boud and his colleagues (1985) stress the relationship between the learning experience and the learner actively going back to review that experience. The first stage of their model of 'reflective learning' involves recalling or getting back to a learning event in order to reconstruct it. Their second stage is about 're-evaluating experience' where new knowledge is related to existing knowledge and in the process the learner's conceptual framework is developed. Boud *et al.* say that these processes involve feelings so the learner needs to 'attend to feelings' by exploring the beneficial aspects of that experience as well as exploring and removing feelings that would obstruct learning. They suggest that

the outcomes of reflective learning could include changes in behaviour, a greater perspective on experience and the ability to apply and act on learning.

Another publication issued to me as an Associate Lecturer was the 'Supporting Open Learners' reader (Open University 1996a). This describes an adaptation of Kolb's model of experiential learning (1984). It suggests that the learner begins with 'abstract conceptualisation' and moves round the adapted cycle via 'active experimentation' through 'concrete experience' and 'reflective observation' and then round the cycle again. Kolb (1984) defines learning as 'the production of knowledge through the transformation of experience' and he intended his model of learning to be used by both academic learners and practitioners. The *Open Mathematics* course materials also use an adaptation of the Kolb model (see later in this chapter).

I found Schön's model of reflection (1991) to be difficult to understand and sometimes confusing. Briefly, I understand it to have two stages, 'reflection-on-action' which occurs after action and 'reflection-in-action' which takes place in the middle of activity. Schön's model is perhaps more useful for professionals reflecting on their own practice rather than for students, especially those such as *Open Mathematics* students who are often new to study or returning to it after some time away.

I found it relatively easy to understand the process of 'reflection' in relation to examining my own practice but it was more difficult to make sense of the abstract notion of 'reflective learning'. At the time I was struggling with these ideas, I attended a seminar on what I thought was going to be a subject unrelated to reflection. During the session, the leader of the seminar, John Cowan described three types of reflection so clearly that I left the seminar with the slogan 'reflection on, in and for action'. I found his description of a model for reflection easy to remember though not always so easy to apply. I quote here

from my notes made on the day though they are also in his book (Cowan 1998). The first two categories are derived from the work of Schön (1991).

> *Reflection-on-action mainly looks back on the action contained in past experiences; it attempts to analyse and summarise that past experience, and thereby extract generalizations which will be of future use.*
>
> *Reflection-in-action looks backward to immediately past experiences and forward to experiences which are imminent. It entails as much anticipative thought and analysis as retrospective review. It is a reflection which should for example lead to improved or at least carefully premeditated performance.*
>
> *Reflection-for-action establishes priorities for subsequent learning by identifying the needs, aspirations and objectives which will subsequently be kept prominently in a learners' mind.*

Since then I have tried to actively apply Cowan's model, in a simplified way, to my tutorials with my own *Open Mathematics* students. For example when preparing for the tutorial I try to 'reflect-for-action'. Have I considered the learning needs of my students and prepared suitable material? 'Reflecting-in action' takes place during the tutorial itself, what is working well, what might I have to do differently next time. After the tutorial comes the 'reflection-on-action' when I think *how* I might adapt my approaches or materials for the next time. Making sense of the model in one context helped me to apply to it another, that of learning, in particular making it more structured and active, though I still find it difficult and can well understand the problems students who are new to the process might have.

Cowan also explained what he called his 'double Kolb' or 'loopy' model of 'reflection in action'.

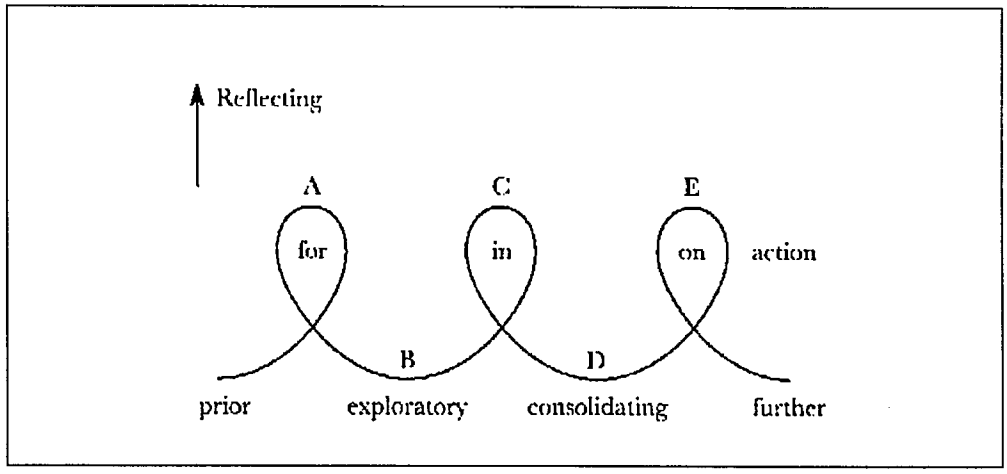

Figure 1 The Cowan Diagram

'On Becoming an Innovative University Teacher: Reflection in Action' (Cowan 1998) p.38

At last I had found something that made sense to me and has proved useful for me personally. It also perhaps illustrates my preferred way of working: auditory and with diagrams rather than complex text.

Recently I have found Moon's work useful (1999). She reviews the literature of reflection in both learning and professional development and concludes that the apparent differences relate not to the process itself but to 'the different applications and frameworks of guidance that shape them.' She suggests that reflection is needed for a deeper approach to learning and there are three areas where it is used: in initial learning, in the processes of representation and in the upgrading of learning. Reflection in initial learning is for making meaning, working with meaning and making sense of ideas. Upgrading of learning often occurs later than initial learning and can be transformative leading to deeper learning. This kind of learning can often be helped by discussion in small groups or responses to appropriate questions from a teacher. One way of upgrading learning is in the reflection used while representing learning, for example entries in a learning journal or activities (written or spoken) designed to encourage arriving at deeper meaning.

Reflective learning in distance education

Lockwood (1995) and Morgan (1993 and 1995) discuss the problems and issues of adult and distance learning in general whereas Thorpe (1993) writes about reflective learning in Open University courses. She reminds us that course materials provided for distance education courses are so complete and comprehensive that the views of the course team can become dominant, making it difficult for students on these courses to have independent thoughts. As a result 'critical, reflective capacity is not developed by the learner'.

Thorpe (1995) also reports on case studies of students from two Open University courses that were explicitly designed to foster reflection on experience integrated with conceptual learning. Both courses were in the field of education. The first, *Approaches to Adult Learning*, was part of a professional diploma programme and students were asked to reflect on their practice in delivering adult education and training. All the students on this course had some direct links with education and training and were experienced learners so it is perhaps not surprising that most of them were positive about the value of reflection, both personally and professionally. The study found that stepping back from practice to reflect was a good idea but it needed to be integrated with the theory. The results also showed that writing in a journal that was not assessed by a tutor did not help to stimulate critical reflection. Another finding was that students showed a much greater diversity of approaches to learning than had been expected, something I hoped to show in my own study, albeit with a very small number of participants.

The second study reported by Thorpe (1995) involved students on *Learning Through Life: education and training beyond school*. Although this was an undergraduate course, many students were continuing or associate students so again they were experienced learners, unlike the majority of *Open Mathematics* students (at least in the early presentations of the

course). Over half of the *Learning through Life* students in the study said that they found reflection difficult to do though by the end of the course most of them felt they had a better grasp of it. It may be significant that the students who had a more positive attitude to the reflective aspect of the course were the 'associate' students many of whom already had a degree and were involved in jobs in education.

Learning and *Open Mathematics* (MU120)

Shiu (1996) considers some of the practices of Open and Distance Teaching where emphasis had been on reflective learning and then relates these to the Open University Mathematics Entry courses (which includes *Open Mathematics).* She raises the important question of whether the habit of reflection can be gained by older learners especially when their previous experience of mathematics learning has been quite different and she looks at the particular challenges of introducing active and reflective learning into distance education courses.

Shiu describes precedents for the use of a Learning File in other courses. In many cases they have proved successful in situations where the teaching is the more conventional 'face-to-face' (Countryman 1992, Waywood 1992, 1994) rather than 'distance learning'. As we have already seen in the previous section, Learning Files had been found to be beneficial in two Open University courses (Thorpe 1995) though these were not first level courses. It was decided that for the *Open Mathematics* Learning File the following principles should be satisfied (Shiu 1996):

- the Learning File must be presented as an essential, integrated and legitimate part of the course;

- it must be introduced at an early enough stage to become a natural part of the study;
- adequate time must be allowed for its use;
- sufficient and appropriate support for its use must be provided;
- its use must be rewarded in the short term through assessment (even though we believe its chief value may well lie in the long term acquisition of a reflective approach to learning).

Taken from 'Learning to Learn Mathematics' (Shiu 1996 p.6)

Shiu describes how these principles have been addressed for *Open Mathematics*. In the early stages of the course presentation there was little feedback from students; but Shiu points out that although immediate gains were important the longer term ones were even more important in helping students establish and pursue active habits in 'learning to learn mathematics'.

Hodgkinson and Wright (1999) reported on a study of *Open Mathematics* students where the focus was on evaluating the effect of integrating Key Skills into the course. Data were collected by questionnaire after the end of the course with some telephone interviews. As the students in the survey were studying *Open Mathematics* at the same time as the students in my study, their findings are useful, to some degree, for making comparisons.

Open Mathematics materials

Students in my own study were unlikely to have been exposed to or to have read the literature of reflection in learning or to have practised it knowingly but they did have the opportunity to meet it in their *Open Mathematics* course materials. In Unit 1 *Mathematics*

Everywhere (Open University 1996b), the final section aims to help students think about how they learn mathematics. Students are encouraged to become 'active' rather than 'passive' learners and are reminded that learning is not instant but takes place over time.

One of the main messages is:

> *Long-lasting learning that stays with you comes about from reflecting on (here, mathematical) experience and integrating into what you already know.*
>
> *Open University 1996b, p 39*

To help students achieve this 'long-lasting learning' they are offered a simplified version of Kolb's (1984) cyclical model of reflective learning:

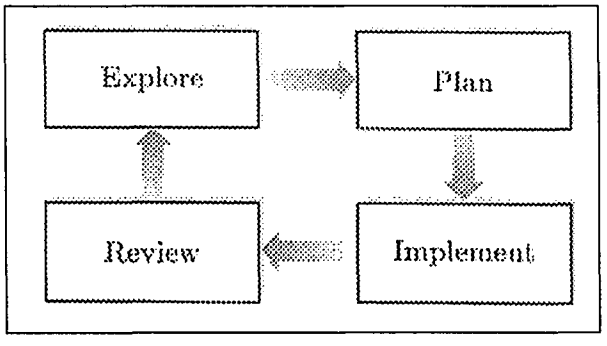

Figure 2 Cyclic model of reflective learning

Open University1996b p44

An expanded version of this model appears in 3D form as a spiral in the final Unit 16, *Rainbow's End* (Open University1996c):

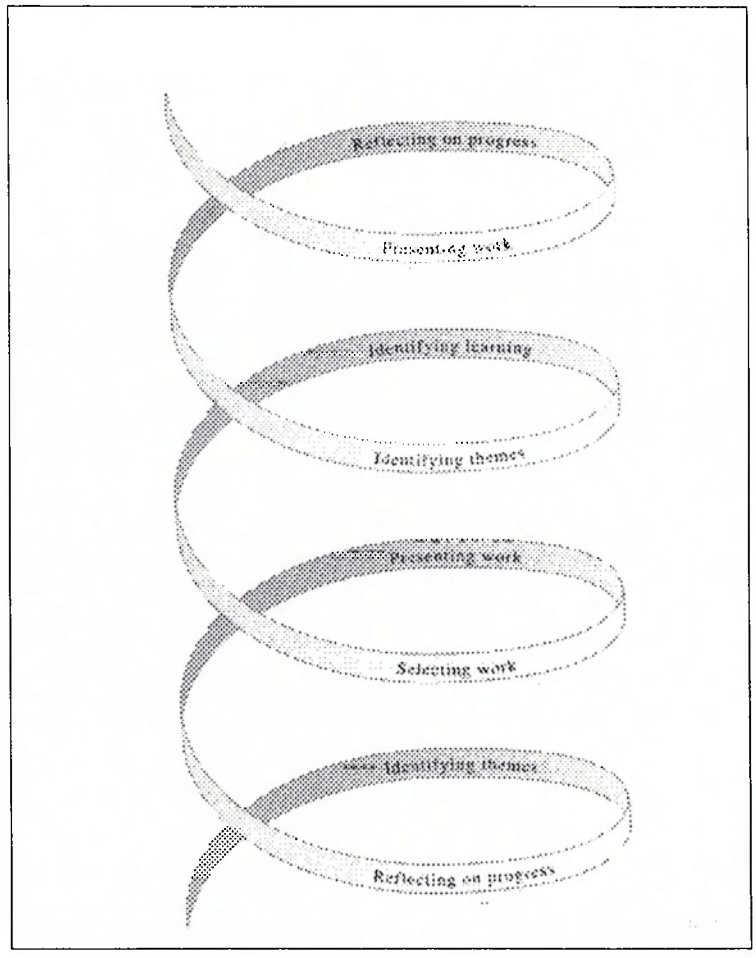

Figure 3 Three dimensional cyclic model of reflection

Open University 1996c p 28

Section 3 suggests a useful approach for students to use as they review their work in preparation for the end of course assignment. Stage 5 of this approach (page 27) gives a working definition of *reflection*.

Reflection means:

- thinking about the work you have done;
- identifying what you have learned from it;
- generalising your learning experience so that you can apply your skills and techniques to new situations.

Finally

Issues from literature about metacognition and reflection as reviewed in this chapter have been helpful to me as a researcher. However, the *Open Mathematics* students who were the subjects of my study are unlikely to have come across such a range. They would have met the models used in *Open Mathematics* as summarised in the previous paragraph so these alone will be used in the comments in the individual stories that follow in Chapters 3 – 7. A wider range of ideas about reflective learning may be used in Chapters 8 and 9 while considering the overall results and conclusions of this study.

CHAPTER 2 METHODOLOGY AND METHODS

This chapter covers methods of enquiry, issues arising from interview methodology and the design of the research including details of how the interviews were conducted and analysed.

Selection of Methods of Enquiry

This section includes a discussion of naturalistic and narrative inquiries and phenomenography.

Naturalistic Inquiry

Because I wanted to find out about the lived experience of *Open Mathematics* students, many of the principles and characteristics of naturalistic inquiry guided the direction of my research study initially. Lincoln and Guba (1985 pages 37 – 43), in describing naturalistic inquiry, stress that realities are both multiple and constructed just as I would expect to get from the students in my study in their descriptions of their learning. I could also expect to find variations between students and within individual students themselves. What the students would say about their experience was their *own* construction. Lincoln and Guba also describe the relationship between knower and known as being interactive and inseparable rather than independent. For me this meant that the questions I asked and how I asked them would influence what students chose to tell me. It might also affect what they became aware of as they talked about their experience. Lincoln and Guba also point out that naturalistic inquiry studies are likely to be value-bound rather than value free and that during the analysis distinguishing causes from effects can be difficult.

Naturalistic inquiry usually takes place in a natural setting so I planned to interview each student in their own home, the usual place of study for distance-learning students. I was a

part-time research student with limited time available so the number of students to be interviewed was kept small to enable in-depth interviews. This meant that only qualitative methods were feasible. I was aware of the pressures felt by many Open University students so random or representative sampling was not aimed for. Instead, volunteers were sought, which resulted in seven students from two tutorial groups for the pilot study and five students from one tutorial group for the main study. I expected that this would provide a range (albeit small) of experiences and views about learning and would give me more detailed information than I would get from normal contact with my own students during the course. As a tutor for *Open Mathematics* I was familiar with the structure, content and philosophy of the course so with these shared experiences I hoped this would increase the chances of effective interaction with the students and thus capture a variety of realities.

Naturalistic inquiry is based on Grounded Theory; the research being 'grounded' in the sense that the theory is expected to develop from the data rather than from an *a priori* theory leading to the research study. Theories are grounded in the subject's experiences with the researcher adding their own insights. In my study it was to be the individual's reported experience of learning that was investigated and subsequently interpreted and analysed, making use of my experience as a tutor as well as using my insights as researcher.

Not knowing at the start how my study might develop, it was reassuring to learn that studies based on grounded theory unfold as they proceed rather than strictly follow a detailed plan made at the start. Glaser and Strauss (1967 p 105) describe the process as being:

> *... a continuously growing process, each stage after a time is transformed into the next. Earlier stages remain in operation simultaneously throughout*

> *the analysis and each provides continuous development to its successive stage until the analysis is terminated.*

In my study, each interview would be transcribed and then used to determine questions for the next interview. In naturalistic inquiry studies outcomes are often discussed and negotiated by researcher and subject together. However, in my study, although meanings were explored in the second and third interviews the subjects were not directly involved with interpreting meanings.

Studies based on naturalistic inquiry are usually reported as case studies as this allows for descriptions of multiple realities and can show how a researcher has interacted with a subject (and so makes any consequent bias more transparent). Interpreting data and drawing conclusions can be done in terms of each particular case i.e. idiographically. The findings may only have tentative applications to other studies, because the realities are multiple and different and depend on the particular interactions between the researcher and the subject. For these reasons it seemed unlikely that my study, if it used such methods, could be exactly duplicated in further studies or that it would be value-free.

Narrative Inquiry

Kvale (1996) describes a narrative approach as one where the research interviewer sees the investigation as story-telling. In this study, to an extent, information about the subject's experience of learning and their awareness of it was gathered in the form of small stories especially where examples were sought. My presentation of data is in terms of a story I tell arising from studying the data.

Connelly and Clandinin (1990) view narrative as both method (narrative inquiry) and phenomenon (inquiry into narrative). This type of inquiry focuses on individuals by recounting and interpreting life stories, though in my study it is limited to stories about

their learning with some relevant biographical details. In order to get a clearer picture of their experience, students were encouraged to respond to my questions with narrative accounts rather than give short answers to a list of pre-prepared structured questions.

While writing narratives can be useful in making sense of experiences and enable explanations and justifications, care has to be taken to avoid stereo-typing (Mason 2002 page 62). Mason's ideas of 'accounts of' and 'accounting for' are heavily used in the analysis and interpretation of the learning stories that make up the bulk of this report and they will be described later in more detail.

Phenomenography

Some aspects of phenomenography have proved useful in this study. For example, one aim of this particular methodology is to *'find and systematize forms of thought in terms of which people interpret significant aspects of reality'* (Marton 1981). Marton regards phenomenography as complementing other kinds of research as it aims at description, analysis and understanding. He describes two types of perspectives on conceptions of reality. The first order is description of various aspects of the world and the second is description of people's experience of the world. Phenomenography is more concerned with the latter perspective.

Mason (2002 page 200) says that phenomenography 'works to reveal a range of types of experience in order to appreciate the lived experience'. Researchers using phenomenography look to discern variation and differences between the way people experience, perceive and understand a phenomenon. Data are usually collected by dialogue-type interviews and the subsequent analysis examines the language used as well as exploring the meaning.

In the prologue to *Learning and Awareness*, Marton and Booth (1997) describe phenomenography as a research specialisation that:

> *actually seeks the variation in ways in which people experience situations and phenomena in their worlds, generally studied with an educational research interest.*

My aim in this research study was to investigate the variety of awareness and experience of learning in *Open Mathematics* students, so phenomenography seemed an appropriate research methodology.

Interviews: methodology and issues arising

Although interviews were used to collect data for this study, other methods of data collection were also considered but rejected as being unsuitable. Questionnaires might have been less time consuming and easier to analyse but the information gained would have been limited. Feedback from diary or journal entries could have been useful but would have taken too much of the students' time and requests for copies of completed reflective type learning activities could have been regarded as being intrusive.

Types of interview

Kvale (1996) describes an interview as:

> *...literally an inter view, an interchange of views between two persons conversing about a theme of mutual interest.*

and defines the semi-structured life world interview as being:

> *... an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena.*

I found this related well to my study where the mutual interest was the learning aspects of the course *Open Mathematics.* My purpose as researcher was to find out more about the awareness of each student of their own learning by asking them questions, for example about changes in their learning with particular reference to the learning activities incorporated in the course materials.

I was introduced to Kvale's work after I had started my study. At the time of deciding which form of interview to use in this study, I found the following description of four types of interview given by May (1997) helpful.

Structured interview

This method usually relies on a questionnaire to collect data with each question being given in the same way to each subject so there is little or no room for deviation or for probing. The interviewer's role is therefore neutral and indeed the interviewer may not even be the researcher. An advantage of this method is that it allows easy analysis and makes valid comparison viable. However this method would not have been suitable for my study as there would not have been enough scope for probes or exchange of view and at the start I did not have a complete list of issues that might arise.

Semi-structured interview.

In this type of interview questions are prepared before the interview but there is room for more flexibility with opportunities for elaboration and probing to seek clarification. This type of interview would be more appropriate than a fully structured one as I expected students to highlight different issues and raise unexpected ones.

Unstructured or focused interview

This type is more open-ended. The researcher states the aim of the study but there is a more equal partnership between interviewer and interviewee and a chance for the subject to question or even challenge the perceptions of the researcher. This type of interview could help to uncover meanings about learning from the individual student but there was a danger that the discussion could move too far away from the issue of learning.

Group interview

The advantage of group interviews is that group norms and dynamics can be investigated. A disadvantage is that, again, the discussion may move away from the topics chosen by the researcher. Practically it would have been difficult to gather together a group of *Open Mathematics* students without using up valuable tutorial time. Even if it had been practical students might not have felt free to express their own views and ideas in a group setting and it was important for me to collect a variety of learning experiences. It was known, from reports from tutors and postings on the *Open Mathematics* First Class newsgroup, that there had been some opposition to the 'Learning File Activities' (also Hodgkinson and Wright 1999 p. 127). For these reasons it was important that students should be interviewed alone enabling them to feel free to express their own views and ideas.

Choice of interview

May (1997) points out that in practice a researcher might use a mixture of two or more types and in this study the first interview was planned to lie somewhere between a semi-structured and unstructured/focused interview. Although the core of questions used for each interview was the same, I expected that the questions might be used in a different order for each student and different probes would be needed depending on the student's replies. In the pilot study each student was interviewed just once and the results of the

interviews were helpful in deciding the final questions and form of the interviews for the main study.

Interview questions and structure

As a novice interviewer it was helpful to consider Kvale's (1996) review of the different types of interview questions for the later interviews (after I had access to his work). For example 'introducing questions' can encourage 'spontaneous rich descriptions' and 'follow-up questions' provide extended answers. 'Probing questions' can produce further detail from the interviewee and 'specifying questions' can produce even finer details. 'Structuring questions' can be used to signal a change of direction or topic and the absence of questions, silence, may encourage the interviewee to break the silence with further reflection. Kvale's final category is 'interpreting questions' when the researcher asks for rephrasing or clarification so that the subject has an opportunity to clarify or refine aspects of the interview. This could avoid possible confusion or dissatisfaction and ends the interview on a positive note. I tried to be aware of all these types of questions in the second and third interviews though one of Kvale's types was not necessary, that of indirect questions about attitudes of others, as I was only seeking information about the student's *own* attitudes to learning.

Influence of researcher on interviewee and relationship between them

In considering aspects of the interview situation that might affect the outcome, May (1997) suggests that ideally there should be a match of aspects such as gender, age and accent. It turned out that in the main study I was the same gender as three of the five students. Finch (1984 p.72) found that a woman interviewer achieved a better rapport with women subjects than with men, which suggested that I might obtain more information from the female subjects. It is difficult to judge whether this was the case in this study and the transcripts were not analysed with this in mind. My subjective feeling is that, as the series of three

interviews progressed, the interviews with the women students became easier than those with the men. This may however have more to do with the attitudes of this particular set of students. Although both men agreed at each stage to be interviewed, one said he was only doing it to please his tutor and the other said that he couldn't understand why I should want to travel some distance just to find out *his* views as there was nothing special about them.

The students were aware that I was an *Open Mathematics* tutor so they were able to make detailed and specific references to the course materials during the interviews. Possibly this might encourage them to use some of the language of learning from the course and enter into discussion more easily. However, I deliberately planned not to introduce specialised language myself unless they had used it first. I was also aware that the students might not perceive a tutor/counsellor to be an equal (even though the Open University stresses equality) so this could make a balanced two-way discussion more difficult and my role could be perceived as being biased rather than neutral. To help counteract this I planned to tell them that I too had been a student on Open University undergraduate mathematics courses in the past and was currently an Open University research student.

I knew that a series of three interviews gave opportunities for my role to change as they got to know me better and more discussion about learning might lead to deeper discussion the next time. Also, between the first and second interviews the students were being exposed to several more learning activities in *Open Mathematics* and could develop their use of specialised language. On the other hand, I could be seen as a representative of The Open University, and so be a target for criticism of the course, regarding both its content and procedures. This did happen with at least two of the students and at the time I had to consider carefully how to respond in order to maintain a balance between me as researcher and the student as interviewee.

Practicalities

Mishler (1986 p. 7) views interviewing as a form of discourse between speakers with culturally shared assumptions using 'ordinary' language competence. However (p. 51) he suggests that the meanings of questions and answers are problematic and 'all answers depend on the way a question is formulated' (p. 2). For this reason obtaining a good recording of the entire duration of the interviews was essential so they could be carefully transcribed and provide data for my subsequent analysis.

Video-recorded interviews give useful verbal and visual data, for example, facial reactions and hand gestures, but they would have been complicated to do and the subjects might have felt inhibited by a video camera. Instead the interviews were audio-recorded (with the subjects' agreement). Some hand-written notes were also taken during the interview to remind myself of further questions to ask and material that needed to be summarised at the end.

Analysis

This section looks at the analysis of data and briefly describes the methods used. Although, inevitably, it took a long time to transcribe the tapes and check them it was helpful to know that this was not a 'waste' of time. On the contrary, it was an opportunity to become familiar with the interview data, what May (1997 p.126) describes as the first stage of analysis.

One of the first methods of analysis to be considered was Kelly's personal construct theory using repertory grids (1955). Kelly's views seemed appropriate to this study, that is that people are actively engaged in making sense of and extending their experience of the real world. He said that there is no absolute objective truth so the meaning of events is related to the way they are construed by individuals.

Cohen and Manion (1994 p. 309) suggest that a repertory grid technique is 'equally adaptable to the problem of identifying changes in individuals that occur as a result of some educational experience'. It would seem that using a development of Kelly's personal construct theory and repertory grids could be a way of trying to remove the researcher's frame of reference. It could also act as a mechanism for looking at data objectively so that the theory would develop from the data rather than the other way round.

In my research the personal constructs would be the dimensions used to conceptualise learning. In order to get started I took triads of interviewees using transcribed data from the first two interviews and looked at ways in which two were the same and the third was different. However finding the constructs (and also deciding which were constructs and which facts) proved to be difficult and time-consuming so this method, although potentially useful, was abandoned. It was at this point that I wished I could start the study all over again!

Instead I moved to Kvale's methods and ideas (1996) for analysing data. He says the transcribing stage:

> ... *involves translating from an oral language, with its own set of rules to a written language with another set of rules. Transcripts are not copies or representations of some original reality, they are interpretative constructions that are useful tools for given purposes.*

Kvale (1996 p 189) describes six steps in the analysis of interview data, the first three being during the interview itself. In the first step subjects discuss their 'lived in' world. In the second step, interviewees may see new meanings in what they experience or do; and in the third step the interviewer in the course of the interview 'condenses and interprets' what the interviewee has said so that he or she has an opportunity to make corrections.

These steps take a short time whereas, as has been stated earlier, the fourth step is the most time-consuming (and seemingly never-ending!). This fourth step consists of three parts. In the first the interview material is prepared for analysis and in this study was produced as written transcription from the audio-tapes. The second part involves clarifying the material and deciding which parts of the material are important. The third part is the 'analysis proper' when the meanings of the interviews can be developed. For this 'analysis of meaning', Kvale describes five main approaches: condensation, categorisation, narrative structuring, interpretation and ad hoc methods. These will be used and described in more detail later in this chapter.

In this study it was appropriate to act on Kvale's fifth step and re-interview in the sense of checking data in later interviews obtained from previous ones. However it was not appropriate for the purposes of this study to carry out his final possible sixth step which would include *action,* where researcher and interviewee are acting together, for example in a therapeutic situation or in action research.

Interpretation

In discussing the plurality of interpretations from interview data, Kvale (1996) asks whether:

> *the purpose of a text interpretation is to get at the author's intended meaning of the text ... or does it concern the meaning the text has for us today? (p. 211)*

In my study, although I was hoping to interpret the students' intended meanings, it was also important for me, as a tutor, to be concerned with their expressed ideas. It was therefore essential to produce an 'account of' what the interviewee said before 'accounting for' (Mason 2002). The 'account of' is as objective a description as possible of what happened or what was said by eliminating value-laden and emotion-laden words from the

researcher's summarised descriptions. 'Accounting for' attempts to explain, evaluate and interpret meaning behind it. It is a subjective account and other researchers might use the same data or different parts of the data but interpret them differently. Recognising this, an attempt is made to explain why a particular topic or theme was chosen for description and exploration and what resonances are noted.

In writing the 'accounts of' it was helpful to consider Kvale's 'meaning condensations' (1996) as I reduced the transcripts into briefer, more manageable sections. However while thinking about the interpretations of meanings (Mason's 'accounting for') I found it necessary to return again and again to the full interview transcripts.

Research design and what I did

At the start of my research, I was given permission to interview *Open Mathematics* students by the Open University staff tutor in the region where I work as a tutor (Associate Lecturer). Tutors of two groups in the region agreed to ask their students if they were prepared to take part in my study. With the students' agreement, their names and contact details were passed to me and I wrote a letter to each one giving them brief details about the study and asked if they would agree to be interviewed. At this first stage all of these students agreed to take part as they did in the later stages of the study. To avoid these students being involved in too many research studies it was agreed at an Entering Undergraduate Mathematics Research group meeting in the Open University Faculty of Mathematics and Computing [November 1995] that no other research would be carried out with *Open Mathematics* students in this region, apart from the routine random selection of students by The Open University Institute for Educational Technology for evaluation purposes.

The pilot study

In the early stages of the study I was not very familiar with the *Open Mathematics* course and had limited experience of working with adult learners. The pilot study enabled me to gain more knowledge and experience of these two aspects as well as giving me the opportunity to practise research techniques and trial questions with students. In order to practise interviewing, recording and transcribing techniques, single interviews were carried out with seven students from two tutorial groups mostly in their own homes though in one case in their workplace. The interviews took place after the end of the course to avoid added pressure on the students and before the results were released as these were not relevant to the study.

The initial questions in this pilot study were designed to find out about the students' previous experience of learning and studying. The students were then asked to describe high, low and turning points in their learning during the course. Their responses helped to form the questions and structure for the main study. It was found that the students were keen to relate their experiences but there was a problem keeping to the subject of learning. Accounts of high and low points tended to be more about feelings than learning. I noted later that Mishler (1986) had found the notion of investigating high and low points to be 'remarkably unsuccessful' as it was difficult to achieve a shared understanding of these terms with the interviewees.

Initial analysis of the transcripts revealed many issues about learning which were helpful to me as I prepared to tutor this course. These included:

- writing about mathematics was deemed to be difficult and a new experience for some;

- the format of the learning activity sheets did not suit all students so some had designed their own. One had recorded 'exciting' learning experiences calling it her 'goodie' sheet;
- the most used learning activities in order of usefulness were 1) planning 2) handbook and 3) reviewing;
- students felt they were not yet familiar enough with the vocabulary of learning;
- evaluating one's own work was unfamiliar for some;
- a common reason given for not doing the learning activities was 'lack of time';
- some students said they realised that the value of the learning activities might not become apparent until after the end of the course.

While discussing this last point with Christine Shiu I realised that this was the basis of another research question: "is there an effect on the learning of students as a result of studying *Open Mathematics* even if they have not written about these changes in their learning files?" How these changes could be recorded or measured would not be an easy task but it caused me to rethink the focus of the first interview in the main study.

The main study

Five volunteer students from one tutorial group were the subjects for the main study. (In this report they will usually be referred to as 'students' rather than subjects or interviewees.) *Open Mathematics* is the first Open University mathematics course where the numbers of women are about the same as the men. This balanced ratio of 1:1 is regarded as being an improvement on that of the previous entry course for mathematics the Mathematics Foundation course, M101, where it was 1:4 women to men (Hodgkinson and Wright 1999 p. 55). It was therefore important to achieve a roughly equal balance of men

to women in this study and this was almost achieved with three women and two men. One of the students was of Asian origin, another was a continuing student in her second year with the Open University; four were studying with the Open University for the first time. Three students had work-related reasons for studying. All five students gave informed consent for participation in the study but to preserve their anonymity their names have been changed to new ones which retain gender and ethnicity. I have named the students Anna, David, Helen, Neil and Usha.

The group of five students thus provided some variety though I recognise that it was unrepresentative of the *Open Mathematics* cohort as a whole. All five were committed enough, and also able, to attend tutorials so some categories of students were not included; for example, those who are unable to get to their local tutorial centre because of evening work, illness, disability or lack of transport or who choose to study with the Open University to avoid direct contact with others.

Although the results of this study are not generalisable through representative sampling, there is enough data enough to inform my own practice and perhaps that of other tutors and writers of course materials. There is enough variety to illustrate a range of responses and there is some opportunity for making comparisons. Generalisation could arise when other tutors who read the stories might recognise and be informed by what the students in this study had to say. I have tried to use my own sensitivities, experiences and sensibilities to inform my analysis.

Framework of interviews

Collecting data for the main study took place over a period of eighteen months and consisted of a series of three interviews with each of the five students. Before the

interviews and the development of the study are described in detail an outline framework is given here.

Table 1 Outline Framework of Interviews

Interview	Year	Month	Comment and Aims
1	1	June/July	About half way through *Open Mathematics.* *Aims:* 1. to learn about any changes in learning since the start of the course; 2. to act as a 'baseline' for the next interview.
2		Nov/Dec .	After the end of *Open Mathematics* but before any results published. *Aims:* 3. to clarify and probe data from first interview; 4. to find out students perceptions of learning.
3	2	Nov/Dec	After most Open University courses have finished but before any results published. *Aims:* 5. to check and review ideas about learning gained from previous two interviews; 6. to probe ideas about 'reflective learning'.

Interviews in detail

Interview 1

The first round of interviews took place in the students' homes about half way through the course at a mutually convenient time. One subject, Anna, worked part time so a morning visit was most convenient for her while her son was at school. The other four were at work in the day time so their interviews were carried out in the early evening. As I was visiting their homes as a semi-invited 'guest' I decided to keep the relationship relatively formal by turning down (politely I hope!) all offers of tea or coffee. I succeeded in this except for one interview in the third series when coffee was brought in by the subject's wife and it seemed churlish to refuse it. They were asked to have their Learning Files available (even if they had made few or no entries) in case they needed them for reference. The interviews were expected to last about 30 minutes though, in the event, some of them lasted longer.

At the start of the interview I explained that the principal aim of my study was to collect data from *Open Mathematics* students about their learning for the purposes of my research degree but the information would also help to inform me as a new tutor for the course. The structure of the interview was then outlined and I had a 'pro forma' recording sheet to make notes during the interview with headings:

- Changes in their learning in general.
- References made to the Learning File and activities if any.
- References to assignments.
- Other references.
- Summary.

This gave me a framework to use during the interview to help with checking, clarification and summarising. After initial questions about the study background of the interviewees to help put them at their ease, I made it clear that the main question was:

How has your learning changed as a result of this course – if at all?

This ambiguity in this question was deliberate to see whether interviewees would interpret the question as being about content (what they had learned) or about process (how they had learned). Some interpreted it in one way and some in others but David asked for clarification first before answering.

Towards the end of the agreed time I summarised what I had heard from the students:

This is what I think I've heard from you, is that correct?

The students were also offered transcripts of their own interview. All of them accepted this offer so they were sent to them for checking. Finally they were asked whether they were willing to be interviewed again after the end of the course and they all agreed.

Great care was taken with the language I used with the students, and where possible I followed their use of language. I tried not to lead them into more the specialised vocabulary of learning so I deliberately did not use words such as 'reflection' in this first interview

I made notes immediately after the interview about the conditions under which it was held and recorded practical problems such as interruptions to the interview. With the student's agreement each interview was recorded on audiotape using a small dictaphone recorder placed between me and the student. The tapes were later transcribed by me and listened to at least three times, the first one being an initial transcriptions for the words used, the

second for a more detailed check and the third for adding non-verbal reports such as pauses and laughter. The resulting transcripts were sent to the interviewees for their comments.

These transcripts were used to prepare questions for the second interview. I realised that the question about 'changes in learning' was not specific enough and for all the students I needed to try harder to determine what *they* thought learning was. I also planned individual questions for each student to clarify and extend what they had said in this first interview. These are extracts from my notes:

For Anna

> *I would like to find out more about the balance between the learning activities suggested in the course and those she devised herself.*

For David

> *I specifically will not refer to the idea of remembering unless he does. I need to probe his current understanding of learning at the end of the course and, if it has changed, what were the influences.*

For Helen

> *Ask specific questions about what she means by learning and how that compares with study and the organisation of study.*

For Neil

> *Ask specific questions about what he means by learning and how that compares with study and the organisation of study.*

For Usha

> *She described the link between 'doing' and 'knowing' so probe more about this link and whether this is new to her during this year and if so what has influenced any change.*

Interview 2

The second interviews took place about four months later, after the end of the course but before the students received their results. The results of assignments and the end of course assessment were not needed for my study so it had been agreed that I would not ask the students their results nor would the tutor give me such information. Since the last interview students had prepared for and completed the End of Course Assessment and it was possible that the experience of this might have had an impact on their notions of learning and on the role of the Learning File. If the students mentioned this spontaneously they would be encouraged to talk about it but if they didn't prompts would be used. The questions listed in the previous section were used as a framework to check the topics raised in the first interview and then to seek development and extension on selected topics for each student.

After Interview 2

The first two interviews had created a lot of data about the students' views on learning. I was hoping to interview the students for a third time partly to provide some validation of the findings from the previous interviews but also to see what further changes students might report on their learning.

I wanted to make this next interview (and probably the final one) more structured, preferably with some kind of task for the interviewee. I looked through all the transcripts and identified all the statements (ninety four of them) made about learning, printed them out, cut them into individual statements and spread them over the dining room table. At first they looked unmanageable but gradually over the next few days and after discarding the repeats, they settled into three main groups; the details of these are given in the next

section. As this third interview would be more complex I prepared a script and shortly before the third interviews practised using it.

Interview 3

A year after the second interviews all the students agreed to be interviewed for a third time. The first part of this interview was taken up with finding out what courses, if any, they had taken during the year. One student had started an Open University course early in the year but withdrew within the first month whereas the other four students had just completed further courses. This was followed by a brief review of the important points of the previous two interviews.

This third interview was much more structured than the previous two as students were not responding to my questions but to comments previously made by themselves or by other students. It gave me a chance to verify what they had said in the other two interviews and also to observe the way students carried out the tasks; did they make quick judgements or change their minds or even refuse to do them! I was also aware that some of my interviewing techniques needed to be improved in particular speaking too soon. I tried to leave longer gaps so that the students had plenty of time to think about their choices and their comments. My research notebook for one of these interviews reminded me that there were several long gaps where the only sounds were the caged bird cheeping and the water gurgling in the fish tank.

In the main part of the interview students were asked to look at the 'anonymous' statements prepared from the first two interviews. There were three sets: set M for statements relating mainly to *Open Mathematics*, set S for those relating to studying/learning in general and set R for those about reflective type learning. [See Appendices B, C and D]. The cards from each set in turn were placed on a table and the

student was asked to say whether they agreed, disagreed or had no opinion about the statements and then to put them in the relevant piles. The contents of each pile were later recorded. The sorting of the statements produced some questions from the students and this led into discussion. In the last part of the interview students were asked about any future study plans.

An unexpected bonus in this third interview was the opportunity for new information to be shared and avenues explored when I presented the students with statements about learning made by *all* of the students in the study. In some of the individual stories observations are recorded of the time taken to make choices, the method used and whether students chose their own statements or not. The responses to the statements about reflection, revision and learning, the R statements were most useful.

Analysis

After the problems (reported earlier) of using repertory grid techniques I turned to the Kvale approach to analysing interview data (1996 p. 188). This included the following stages:

1. Condensation

   The interview transcripts were divided into small sections, 'natural meaning units' and condensed into a few words to give the main sense of what the student had said. This stage was done in tabular form and found to be useful in removing subjective comments. Stringing the results together would have produced a factual but not necessarily interesting story. This stage is similar to Mason's 'account of' (2002).

2. Categorization

   The various themes that emerged from the condensation stage were looked at in terms of the original research questions e.g. 'What is the student telling me about learning?' Perhaps equivalent to the 'accounting for' stage of Mason. Kvale's detailed coding of categories and sub-categories was difficult to apply to the small sample in this study and at this stage I had to be careful not to categorise or label the students lest I misrepresent them.

3. The structure of meaning through narratives

   I found this approach to be more appropriate for this study. Together with Mishler (1986) it made me consider the sequence of the narrative, the audience and the meaning, the plot, the unity. It encouraged me to look for narratives that were already there, to become a 'narrative creator' (Kvale p 201) and make a coherent story out of the individual parts. I returned to the original transcripts and selected quotes to give examples of the learning experience of each student which could then be used for 'accounts of' followed by 'accounting for'. These episodes were put together to make a story for each student; in most cases this was done sequentially starting from the first interview, moving on to the second and then the third. The exception was David's story and the reasons for this are given at the start of his story.

I was aware that the episodes and quotations I had selected to describe, analyse and interpret would be different from those chosen by others, so near the end of each student's story reasons are offered as to why these particular topics and issues resonated with me. Sometimes, but not always, this relates to my experiences as a student and tutor.

Structure of the stories (Chapters 3 – 7)

The results of the analysis and my interpretation are written up in the following chapters in the form of stories, one for each student, presented in alphabetical order of the assigned names.

Background

Each student is introduced with details about previous experience of study, reasons for taking *Open Mathematics* and other background information. This section is in full width and ordinary type.

Interviews

This is followed by the main story with each item from the interviews being given first as an objective 'account of' in full width normal Times New Roman font. Not all the content of the interviews has been included and the selection of sections and topics has been mine but the 'account of' part of the story is taken directly from what the student said.

> *Quotes from the students in indented italics.*

Each 'account of' is followed by my 'accounting for' (Mason 2002) in Arial font. This font was chosen so that there is a subtle difference in typeface but not sufficient to interrupt the narrative flow. The 'accounting for' sections are my interpretations and explanations.

In some places the topics raised are then related directly to other research using ordinary type, full width.

Postscript

The material from the three interviews is followed by a postscript section that gives details, where available, of the student's future study plans. Again this is ordinary type, full width.

Resonances

The 'resonance' sections are my personal reflections where I try to explain why I chose to include these particular items in the story. Where possible I link the student's experience with my own, so the reader might see where my interpretations are coming from. These are given in ordinary type, full width.

Relating individual stories to original research questions

My answers to the research questions are given and conclusions are drawn for each student.

What I learned about this student's learning

Here I take an issue raised by each student and relate it to my own practice.

CHAPTER 3 ANNA'S STORY

I have to make notes of my own as well so I could put it into my own words.

This chapter describes the learning experiences of Anna, a continuing student, who had already taken an Open University Level 1 course. In particular the meanings and usage of words about learning, such as 'revision' and 'review', are explored.

Background

Anna had successfully completed the Open University Arts Foundation course the year before she studied *Open Mathematics*. She had planned a sequence of courses leading to a degree and hoped eventually to become a primary school teacher. At the time of the first two interviews she was working part-time as a classroom assistant in a primary school. By the time the third interview took place she had moved to another post in the education field where she collected and analysed data. Anna's previous educational experience before the Open University was at secondary school where she obtained passes in several subjects at GCSE (including mathematics) and took vocational courses in the sixth form.

Anna's learning orientation fitted into the vocational category (Taylor 1983) mainly with extrinsic interest as she needed a degree as part of her qualification to become a teacher. There was also some intrinsic interest in that some of the courses she took (for example the Humanities and Mathematics) would be useful for teaching.

First Interview

In this first interview Anna told me about her previous Open University course and described how she made and used her 'revision notes'.

Previous experience of Open University study

Anna said that studying the course the previous year had made her familiar with the Open University systems and also enabled her to try out and develop her own methods of studying. In particular it helped her gauge the level and style of writing required for a degree course. For example, in the early stages of her first course she wrote too much but soon learned to 'whittle' her answers down to an acceptable level. Compared to the 60 point Arts Foundation course the 30 point *Open Mathematics* course seemed quite easy and she found she had plenty of time to do it.

Anna was confident from the start of the course that she could find time to study, an advantage the other students in this study did not have. *Open Mathematics* was a level 1 course, the same level as her previous course though from a different faculty, and at this half way stage in the course she was on target and satisfied with her approach to study.

Anna had other advantages. As a 'continuing' student she was familiar with the administrative and organisational aspects of being an Open University student. She was experienced in dealing with the large amount of material that arrived through the post and was familiar with the assessment processes, preparation and submission of assignments and dealing with feedback from her tutor.

Anna's comments about being able to try out and develop her own methods of studying the previous year could indicate that she was happy with her current methods and so might be resistant to changing or developing them for this new course. Having already experienced writing at degree level she may not have realised that she might have to learn different styles of writing for mathematics.

The Learning File in *Open Mathematics*

Anna observed that a major difference between her previous level 1 course and *Open Mathematics* was that the latter included a 'Learning File' with learning type activities.

Many of these activities are designed to 'help students chart their learning and progress' (*Open Mathematics* Course Guide 1997). Some of them have *pro-forma* response sheets, for example blue handbook sheets (see later) and cream coloured sheets (sometimes described as yellow) designed to encourage students to write about how they learn mathematics and to think about the processes they use and the progress they make. Anna had found the planning activities and associated recording sheets to be 'quite useful' but said that she did *not* like some of the self-assessment and evaluation activities:

> *The ones I don't like are the yellow sheets. I found those very hard. I did the first few but the last ... I don't know I found it very difficult knowing what to put in.*

Even though Anna had been confident about planning and finding sufficient time from the start of the course she still found the planning activities to be useful. Perhaps they were easy and straightforward to complete compared with some of the other learning activities. Anna was prepared to try these planning activities even though she didn't know what was expected of her. In my experience this feeling is shared by other *Open Mathematics* students and is understandable in that some of these activities may be very different from any previously encountered by students in a mathematics context. Examples of such activities include writing about your ideas about the term 'mathematics' (Activity 1 Unit 1), giving examples of how you learn (Activity 12 Unit 1) and completing the sentence 'I am the sort of person who learns well when - ' (Activity 13 Unit 1).

It is also difficult for distance-learners to know their audience. In reality, for the most part, Anna's audience for her written responses to the self assessment and evaluation activities was herself alone, with no feedback from her tutor or opportunities for discussion with other students. These activities can be seen as being personal and private accounts, similar to some extent to reflective diary or journal entries. Yet research has shown that journals are of most benefit when tutors read the writing of their students and enter into a dialogue with them (Borasi and Rose 1989). Waywood (1992) argues that journal entries need to be assessed

and reported on and when this happens they are likely to be valued as much as the more traditional aspects of mathematics.

In the *Open Mathematics* course, the only written activities about learning which *would* be read and receive feedback are the questions in the tutor-marked assignment (TMA) (usually one question per assignment) similar to the 'learning to learn' type activities in the course units.

Shiu (1996) described precedents for the use of a Learning File in other Open University distance-learning courses which were more focused on the process of learning and evaluation than on mathematics. Learning Files have proved most successful in face-to-face situations and in mathematics this has usually been in mathematics education (Waywood 1992, 1994).

In the third interview Anna was asked to comment further on statements made in the first interview about finding the 'yellow sheet' activities hard.

> *I wasn't quite sure what I was supposed to be doing there so I think that's why I found it hard. I wasn't sure what was required, what they needed on those.*

Anna was aware that she did not understand the purpose, content, audience or indeed the way the completed sheets could be used in the future. Furthermore she found they were taking up a lot of time. Possibly she may not have understood the rationale behind these more 'reflective' activities. By referring to 'what *they* needed' she implied that she was being asked to fit in with some other person's model responses, for example those of the course writers (in the case of the activities in the units) or her tutor for the assignment questions. Once she realised that no-one else would read them then, to her mind, there didn't seem any point. She

did not know how she was expected to use these evaluating activities and in this second year of Open University study she may have felt they were not relevant or necessary for her. She did not explicitly state this in any of the three interviews but there were suggestions in later

interviews that she was deliberately deciding which activities would be appropriate for her situation and which were not.

Making revision notes

Anna said that she tried to complete the yellow or cream coloured Learning File sheets provided in *Open Mathematics* but had given up when she found them hard. However it had been easier to use the blue 'handbook sheets' provided for students to record important mathematical techniques, terms and concepts using their own words.

> ... *you had to fill in what you thought they were and I must admit I do try to fill them in'. I do try. A lot of what I've got in here* [showing a large file of hand written notes] ... *I also do revision notes as well after each unit.*

In talking about these blue handbook sheets Anna's tone of voice and the words she used, for example 'admit' and 'try to', showed that she was at least prepared to try them. She was much more enthusiastic when describing the notes she made to her own specification.

Anna explained that when working through the units she highlighted what she thought were the important points and then went back and did revision notes at the end of each module book.

She had made similar notes during the Arts Foundation course. This method had worked well so she decided to continue in the same way for *Open Mathematics* but made some changes:

> ... *normally... when I've finished it* [the module] *then I go back and do the revision notes but this time I've actually done, tried doing it one section at a time ... so it was still clear in my mind. So I thought I'd try that this time and see if that makes any difference, whether it makes it easier or quicker to do it that way as I sometimes find I run out of time...*

Anna was willing to try to improve her learning by modifying her method of study and demonstrated the confidence and ability to do this. Being short of time in her previous course made her aware of the need to develop efficient ways of working. By making notes on smaller sections of material there was less to process before committing it to paper in her words. [At this point I should make it clear that I did not read her notes though I saw the very large file she kept them in.] It seemed important to her to make these notes while the material was still fresh and clear in her mind. It is not clear whether or how she evaluated the changes made but they presumably worked well as in subsequent interviews she referred to continuing to use the new method.

Anna was asked to give more detail about her 'revision notes' and the reasons for making them:

> *...I don't think I could rely on just, on what I'd done on the activities and the actual handbook sheets and the activity sheets ... I 'd have to make notes of my own as well so I could put it into my own words so I can understand what I've done and why I've done it. I find that easier to do.*

Anna recognised that making her own notes in her own words enabled her to make sense of the material and to understand it better. In doing so she was actively engaged in her learning. She did not want to rely solely on the text of the units, the activities or other provided materials. This shows that she wanted to become an autonomous learner and to an extent she was 'self-tutoring'. By making her own notes she was making the knowledge her own. Using the word 'rely' implies that she expected to use the notes in the future.

At this mid-way stage of the course I was surprised to hear Anna use the word 'revision' to describe the notes she was making. 'Revision' used in educational contexts is often associated with 'revision' as in preparing for examinations or alternatively in editing and re-working an assignment or piece of coursework. It seemed as though Anna was using 'revision' in a different way as 'summarising' or 'reviewing'. Perhaps for Anna 'revision' was a label rather than a description; the important word being 'notes'.

From Anna's description of her 'revision notes' they seemed to be similar to those that might be expected as responses [see Appendix F3 for response sheet *pro forma*] to part of the final Activity in most of the *Open Mathematics* Units. Activity 43 'Looking Back' in Unit 3 *Earnings* (Open University 1996d) is a typical example and is made up of two parts:

First paragraph:

> *Now would be a good time to reflect for a few minutes on your progress ... Think about what you knew at the beginning of the units and compare it with what you know now. Ask yourself whether there are any topics which you want to summarise and add to your Learning File...*
>
> *Open University 1996d p. 68*

This part is mainly about reviewing progress in mathematical content and knowledge and Anna did this. She chose topics and summarised them to make her 'revision notes' just as suggested in the above activity. However she stored these notes in a file she called 'Revision Notes' rather than in one labelled 'Learning File', the term used in the course materials. It seemed that she was doing what she had been asked to do in the paragraph quote above but did not realise that this was the case.

Second paragraph Activity 43:

> *Also take time to reflect on your progress you have made in learning mathematics . Which topics in the unit have you found straightforward? Which have you found difficult? Write down what you feel you have gained from studying the unit – for example, a skill you have improved or an understanding of some idea or technique.*
>
> *Open University 1996d*

This is reflecting on progress with regard to acquiring skills and 'learning how to learn'. It was this second part that Anna found 'hard', reviewing and assessing her own learning, the bit she says she 'didn't know what to write'. Although she clearly reviewed and summarised the

mathematical content there was no evidence in this first interview that she wrote about *how* she learned. She may not have seen the point of the activity or have had suitable vocabulary to describe her progress in learning mathematics.

In exploring how these 'Looking back' activities related to her 'revision notes', Anna was asked again what she called this process of making notes at the end of each section.

> ... *well, my note-taking, my revision notes ... it dates back from school*
> ... *you always revise don't you?*

For me, the word 'revision' is usually linked with the secondary process of re-learning work for some kind of formal assessment, whereas Anna seemed to be using 'revision' to describe a continuing process of reviewing and consolidating her learning. In reporting back to Anna what I thought she had told me about the notes I used the word 'review' and asked whether that was the right word. She said that she supposed you could call it that but was clearly not sure. In my experience for a mathematical course, students expect to meet new *mathematical* terms but they may not always realise that they will also meet a new vocabulary of *learning* .

Perhaps Anna was continuing to use a form of learning she had used several years before while she was still at school. It suggests that she was a careful systematic learner, learning continuously rather than leaving things until the last minute.

Hodgkinson and Wright. (1999) asked *Open Mathematics* students whether they had used the Learning File activities which related to the review/evaluation of their work. 80% of the students in the survey reported that they had used them and 60% said that these activities were useful in helping them consolidate their work.

These figures do not tell us how many of the Learning File activities each student used. Moreover the question does not appear to distinguish between reviewing the mathematics (e.g. the blue coloured 'handbook'sheets) and reviewing learning (the cream coloured

'learning' sheets). It would be interesting to investigate whether students differentiate between 'work' as in the mathematical content and processes and work as in the learning process.

Use of 'revision notes'

Anna was asked when she thought she would use her revision notes:

> *Come September. That's why I've done it I think because with it not being an actual exam at the end. If it's an assessment I'd rather have it all ready now rather than try and rush it ... Because you do the activity and you go on and then you keep looking at what you've done to uncover that activity but if you've got it, the main points of the whole unit down in one set of notes ... and then you can go back to each separate activity afterwards if you want to find something.*

Anna here refers to doing 'the activity' having spent time earlier in the interview apologising for *not* doing many of them. On more careful examination it is more probable that she is referring to *her* activity of making and using her revision notes or the activities which are about 'doing the mathematics' rather than the evaluation of learning activities. Whatever the explanation, she showed that she was being thorough, organised and careful; preparing for the future by treating her set of notes as a working document, useful both now and later.

Changes in learning

Anna was asked whether her learning had changed during the course so far. She said that it had:

> *Yes, I think so ... In the* [beginning the] *handbook sheets and the activity sheets it gives you exactly what they want you to write down. But as it gets further on you have to fill your own and I think that makes you think more. You're actually looking for items to go in the handbook activity sheets rather than just looking for the ones they want you to fill in.*
>
> *... at school you have to think for yourself [but] when all is said and done they are university courses and not school ones. Maybe when you start a*

new job you're told what to do and how to do something but after that you have to do it on your own initiative. I think its the same with this, when you first started this course ... and at the end you have to start thinking for yourself, doing it yourself.

Anna recognised that *Open Mathematics* was encouraging students to move from guided to more independent learning. She was taking charge of her learning, looking for opportunities to be active (for example looking for topics to write about on the handbook sheets) and make choices. She compared this process with what happens when you start a new job, something she herself was doing at the time. Certainly as we shall see later her employers recognised that she was capable of working on her own initiative.

There is no evidence that Anna looked outside the course materials while making her notes but this is not surprising. For *Open Mathematics* as with many Open University courses there is usually no requirement or encouragement to look beyond the comprehensive materials provided.

Second Interview

Anna's 'revision notes' are discussed in more detail together with an exploration of her meaning of the word 'revision'.

Using the revision notes

One aim of this interview, which took place after Anna had completed *Open Mathematics*, was to explore connections between the learning activities suggested in the course materials and those devised by Anna herself. She said she had found her revision notes to be useful when completing the End of Course Assessment (ECA) and her revised method of making notes at the end of each section rather than at the end of each unit meant that the notes were more detailed and thus more helpful:

> *...doing it section by section I think the revision notes came in more handy than when I started doing it at the end because I think I missed out bits rather ... more than I did by doing it section by section. I just did what I thought was the main points in each section ... at the time so they were still clear in my mind ...*

It would seem that Anna's revision notes were ideally suited to finding material and examples for the ECA. She had started this type of note-taking early in the course well before the instructions for the ECA were published and expected to use them for the ECA (designed to show evidence of learning). At the time the main reason for doing them was to help her understand the material in the section she had just completed.

> [about the ECA] ... *you had to define a term and define it in the way that is used in that context. That is when I came to use the revision notes ... it was easy to look it up in my notes rather than try and search through and the way I did the notes was not just written out ratio means, bla bla bla but how it actually works in the way we did the units...*

This indicated that Anna had gone further than putting the meaning of a concept in her own words but had related it to the way it was used, its application.

What did Anna mean by the word 'revision'?

Anna was reminded that in the previous interview she had said that 'revision' was a term she had used at school. She was now asked whether there were any other words for what she was doing when she made the 'revision notes'? Somewhat hesitantly she agreed that was possible but said she didn't know what they were. In probing this aspect I commented that in the course materials the words 'reviewing' and 'reflecting' were used quite a lot. Did she feel she was doing either of those when she was making her revision notes or using them later?

> *Probably reviewing thinking about it, yes. Yes because revision, reviewing I suppose, yes you're looking back aren't you, reviewing and going over I*

> *suppose that's what revision is ... sorting out what the very important parts or what I think are the important parts and what are just the padding ... and writing it down 'cos that's the easier way for me to remember it rather than trying to remember it all in my head. I'd rather write it down and then leave my head empty for the next thing.*

I was wary of introducing 'learning' vocabulary that had not first been used by the students and it is interesting to note that Anna picked up on 'reviewing' at this stage and not 'reflecting'. However she now made it clear that she did use 'reviewing' in the way intended by the course team via the units. She also stressed the importance, to her, of writing the notes as a way of remembering. She implied that it is more useful to have work written down than held in her head but it is not clear whether 'remember' means reproducing facts or skills or whether the act of writing helped her with understanding. Anna seemed to be using 'writing to learn' in the more general sense as described by Connolly (1989 p.3); 'helping students to acquire a personal ownership of ideas conveyed in lectures and textbooks rather than the more specific 'writing to learn mathematics'. Countryman (1992) suggests that students construct the mathematics themselves by exploring, justifying, predicting etc. However the material in *Open Mathematics*, in my view, does not lend itself to these latter processes so may not be applicable to students of this particular course.

Anna did pick up on the word 'reflection' later in this interview when I asked her whether she found the diagram on page 29 of Unit 16 (Open University1996c) to be helpful as she prepared for the End of Course Assessment (ECA). The diagram is in the form of a spiral depicting five stages for reviewing (see Literature Review chapter), one of the stages being 'reflecting on progress'.

> *...I did look at it and it made sense... I think the reflecting on progress and the identifying themes was more or less what I was doing with my revision, my set of revision notes and the selecting work, presenting work I think that reflects on how I did the ECA.*

Anna could relate the processes she carried out while making her revision notes to the stages depicted in the diagram. She implied that 'progress' referred to the mathematics rather than learning. Having used the word 'reflect', she now implied another meaning, that of 'show'. It is unlikely that she was comfortable with the word 'reflect' in the sense suggested by the course materials.

Without any further question or comment from me, Anna continued:

> *Reflecting on progress, ...well that will mean going back to sort of not really revision, not the reviewing but its looking back and seeing how far I've come from doing the beginning of the course all the way through to the ECA and looking at the ECA, doing it and thinking to myself 'well yes, 6 months before I wouldn't have been able to have a clue what to do if they put that in front of me there'.*

It may be that before this interview Anna had not really considered what the word 'reflection' meant as used in the course materials. Unit 16 (Open University 1996c) describes three stages of 'reflecting on progress':

a) thinking about the work you have done;

b) identifying what you have learned from it;

c) generalizing your learning experience so you can apply your skills and techniques to new situations.

Anna was clearly aware that she carried out this first stage as she prepared for the End of Course Assignment and earlier comments showed that she also thought about her work at regular intervals throughout the course, probably every few days. At the same time as *thinking* about the work she had done, she *identified* the mathematics content and possibly the skills she had learned as in the second of the above stages, and then wrote her 'revision notes'. By this stage in the interview series, Anna had made no explicit comment about the third stage of *generalizing* her learning experience so she could apply it to new situations, nor had she given

any examples of this. She may well have carried out this third stage but didn't recognise that she had.

Changes in learning

At the end of the interview Anna was asked whether her learning had changed during this year:

> *Yes, I think so. Um I mean the first part of the course, I found quite easy and um as it got harder I had to change the way I was actually studying ... but as I got into things I hadn't done before um it changed the way I sat down and did the studying um um how I did ...I think that was why I changed mid-course about doing my notes rather than wait until the end of the Unit doing it after each section because I found it as the course got harder I found it harder to remember what I did at the beginning.*

Anna recognised that her current method of note-taking wasn't sufficient so she adapted it. Although I had used 'learning' in my question, Anna responded with 'studying'. She used the word 'remember' but it might be that this related more to the process of 'making sense of' and 'understanding' than to recalling information. This is an example where more careful probes by me might have encouraged to Anna to think about the relationship between studying and learning and also between remembering and understanding.

Third Interview

Anna did two more Open University courses the following year: *Using Mathematics* (first level) and *Exploring Mathematics* (second level). She said she had started with good intentions and filled in the Learning File sheets until about the end of Block A. After that she continued making her own notes as she had done in *Open Mathematics* though she still did the 'exercises':

> *Yes. I still did the exercises. I just didn't do the learning after the first Block in the two because I started the new job in April [so]... ... I didn't have enough time to carry on using those.*

Anna made a clear distinction here between the exercises, the mathematics, which she did. and the activities about learning which she did not do after the first part of the course. She gave her reason for not doing them as being lack of time but she may also have felt that she did not need to do them as she was doing her third and fourth Open University courses. She was showing some independence in selecting the activities she thought she needed.

In the two previous interviews Anna referred to the graphics calculator just once, saying she found the programming facilities difficult to grasp. However very early in this third interview she chose the following three statements to agree with most:

I feel a lot more confident in using a calculator

More confident in my mathematics now.

I apply the mathematics in MU120 at work.

As none of these statements originated from the transcripts for Anna's interviews this was an opportunity to explore some aspects that had not emerged before. Anna now felt more confident in using the calculator and in her mathematics so that she was able to use it in her work. I took the third statement as an example that showed she *could* do the third stage of 'reviewing' as described in Unit 16 i.e. 'generalise your learning experience so you can apply your skills and techniques to new situations'

I asked Anna to tell me how she applied mathematics at work. She explained that in her new post she collected pupil data then analysed and reported on them. Nobody showed her how to do this and, in her opinion, her employers did not care how she did it as long as it was done. She said she had used the statistics facilities of her graphics calculator and techniques she had learned from both *Open Mathematics* and *Using Mathematics*.

This information gave further insight into Anna's learning during the course but it also highlighted the limitations of the previous interviews and made me even more aware of the narrowness of the picture inevitably obtained from short interviews.

In general in this third interview Anna picked out most of the statements she herself had made (together with many made by others) so confirming her comments in the first and second interviews. She also expanded on some of her comments. For example:

> *I like written work ... I don't like explaining it to someone else and I don't find re-reading it is enough to learn it.*
>
> *Once I've written it down it seems to get in there.*
>
> *I have to give it a good read and then make my notes ...and put it in my own words.*

Anna's written work was done for herself alone. Making written notes to her own design helped her. She explained things to herself and may have seen no need to explain to others. In this context, 'explaining to others' could have meant that she didn't like explaining something orally. Reading the course materials was not enough for Anna and this time she gave more details of the reasons why she found writing notes in her own words so helpful, 'it seems to get in there', which can be interpreted as deeper learning or understanding.

When presented with the third set of learning statements where the focus was on 'reflection', Anna first picked out the statements she disagreed with:

No-one else sees the reflecting bits so it's not worth spending time on them.

I didn't do the reflecting bits because they are personal.

I don't do things like reflecting on progress.

She said she disagreed with the first one because:

> *I think you need to reflect on it even though no-one sees it ... just to see if you know you really understand what you're doing and if you've actually got somewhere with it.*

Anna first said she 'skipped the reflecting bits' but rapidly qualified this by saying she didn't really skip them; she had done the thinking but had not written anything down. She said she 'did it more in her mind'. She also said she didn't know if she was expected to 'write anything down or anything' but felt there wasn't enough time to do the writing especially towards the end of the course. At this point she had just completed her fourth course and she said she did do 'reflecting' at the end of each one :

> *...looking back after I've finished that one and started the next, I think then you do a lot of reflecting because you can see how much you know now compared with what you did ...*

Anna acknowledged the importance of reflection in the sense of thinking about progress. Although she probably knew that written responses to the reflective activities were recommended she chose to do the 'thinking' but not record her thoughts.

Postscript

Anna started her Open University studies with the Arts Foundation course and then completed the three mathematics entry suite courses. After that she went on to do at least three other courses in Education and in English Language and Literature; so she was well on the way to a degree and her ambition to become a teacher.

My resonances with Anna

I chose to explore the issue of Anna's 'revision notes' because her use of the phrase to describe regular activity and use was different from my own. In my experience the word 'revision' is usually applied to a return to previously learned work. I had expected to find

students either did not use the word 'reflection' or used it in a more everyday sense but was surprised to find that her use of the word *'revision'* was very different from mine. This realisation has made me more aware that my students may use words, especially those to do with learning, in a different way from me.

So now, in early tutorials with my *Open Mathematics* groups, I have included some of the learning activities from Unit 1, Activity 12 *Describing your own learning* and Activity 13 *Your approaches to learning.* By asking students to discuss these topics in pairs and then report back (on each other) to the rest of the group they have had opportunities to use the language of learning and to appreciate that people may have different ways of learning. This has led on quite easily to discussion about active and reflective learning and ways of improving these skills. I also tutor on the pre-level 1 access type course, *Openings*, where all tutorials are carried out by phone. For this course, explicit discussion about learning between student and tutor is *expected.* I have found this experience has given me the confidence to discuss learning more freely with my *Open Mathematics* students too when I make my introductory phone calls early in the course.

Relating Anna's story to the original research questions:

As with all the students in this study, answering the original research questions has not been an easy task. Each student's story provided me with rich data and opportunities to explore many issues on learning and studying, some expected, some not. As a tutor I try to write comments on a student's learning in a very personal, direct but sympathetic way and I welcome feedback and further discussion. Writing about a student's learning from a researcher's angle means that the audience has a different set of criteria and may challenge my interpretation of what the student has said. It also means that the summarised answers given below may appear somewhat cold and impersonal.

1. To what extent was Anna aware of her own learning?

Anna was aware of the Open University systems and administration. She was a good planner and understood the amount of time needed for the course. She also knew that she needed to make the work her own by continually reviewing her work and creating notes to her own specification to be used whilst studying the course and later for final assessment purposes. Anna was ready to adapt her way of studying when necessary and make changes to suit her circumstances. She wanted to become an autonomous learner /student. Although she was confident in her general writing skills she was uncomfortable about evaluating her learning, especially in written form. She seemed to be more aware of the practical issues relating to her learning than of the process of learning. However at times she admitted that she didn't always know what was happening as she learned but recognised that one way of improving her understanding was taking time to 'ponder' and look back.

2. Was Anna aware of any changes in her learning during the course?

Anna was aware that the course was encouraging her to become a more independent learner and so she made choices about which activities would be useful to her. As the course progressed she made more detailed notes more frequently but she did not seem to be prepared to change from her previous ways of learning or even to recognise that there were other ways. Anna implied that she approached her learning in the third year of study in a similar way to *Open Mathematics* and indeed the Arts Foundation course the year before that; she even said that she did the mathematical exercises / activities / examples but not the learning.

3. How did Anna use the activities designed to help learn her how to learn?

Anna became more selective as the Open Mathematics course proceeded. She used the planning activities and the blue handbook sheets but not the cream 'learning file sheets',

saying she didn't understand what she was expected to do. She may not have used them even if she had understood their purpose as her own system of continuously reviewing (or 'revision' in her words) throughout the course seemed to work for her. In later interviews, Anna explicitly separated out the 'learning the mathematics' from 'learning about learning'.

4. Does Anna use reflective type learning?

Anna only used this term in the second interview after I had asked her to comment on the reviewing process for the End of Course Assessment. From her responses to my questions it would seem that she used the stages of thinking, reviewing and, to some extent, generalising and applying, described as 'reflection' in Unit 16 (Open University 1996c) but she was unlikely to use the word itself. However, faced with explicit statements about reflection in the third interview she said that not only was reflection a good idea but that it was necessary.

What I learned from Anna

Anna's story has made me realise that continuing students (those who have already done an Open University course) may have already developed learning styles or patterns that may or may not be appropriate for their next course. They may not see the need for changes to suit a different discipline. Although Anna was confident in her writing abilities at the start of the course she may not have appreciated how writing for the Mathematics and Computing Faculty could be different from writing for the Arts.

Anna's use of learning vocabulary did not always match my own. This raises the issue of how a shared vocabulary of learning can be achieved amongst course team writers, students and the tutors, especially in a distance-learning course where there may be few opportunities for two way discussion or question and answer sessions.

CHAPTER 4 DAVID'S STORY

...I want to learn how to remember, I want to learn how to improve my life...

David had a lot to say so each of the three interviews took much longer than planned. He tended to re-phrase my questions before answering them and often went off along his own line of thought, sometimes losing me on the way. The transcripts of the audio-tapes show that there was much repetition. Many of his comments appeared to me to be irrelevant or contradictory. Sometimes it was unclear whether he was referring to his own learning in previous courses, to that in his current Open University course or to learning done in general or by others. This made analysis and interpretation difficult.

These apparent contradictions could indicate David's lack of certainty about his ideas even though they appeared to be confidently expressed. At times he seemed to be trying to please me as the interviewer but at other times he appeared to express controversial views, possibly deliberately.

Despite these difficulties, David's bad experiences while studying for accounting qualifications provided an opportunity to explore his reasons for choosing to study again after previous failure and to look at his pre-conceptions about the course. At various points in the interviews, David identified and described examples of what he called 'psychological blocks' that acted as obstacles to his learning. Some descriptions of these are given here together with David's own explanations and some of my own.

Careful, prolonged examination and analysis of the second and third interviews enabled many apparent irrelevancies, repetitions and generalities to be removed at the 'meaning condensation' stage of the analysis (Kvale 1996). The resulting data reveal several instances of David's ideas, about learning in general, about his awareness of his own learning and also changes made in his learning as a result of studying *Open Mathematics*.

These are recounted here in this story. Unlike the other four stories in this study, this story is grouped by themes rather than in the time sequence of the three interviews.

Background

David took CSE (Certificate of Secondary Education) examinations at school and later went to evening classes, first for 'O' levels and then for 'A' levels in Economics and Accounts. He passed these with what he described as 'very very poor grades' but subsequently studied for professional qualifications by correspondence tuition on a part-time basis. Although he passed several of these courses individually he said he had never managed to pass the right examinations in the right combinations at the same time, so he gave up. He said he blamed his failure on his 'blocks' but also realised that if he wanted to be qualified *he* would have to change in order to satisfy other people such as the examiners and this he was not prepared to do. He had taken up studying again, this time with the Open University, but had not told anybody, especially not his work colleagues or employers.

> *I don't want anybody to know. I don't want them to say 'Oh, how are you doing?' This is personal.*

David made a point of describing his 'A' level grades as poor and gave a detailed account of his lengthy and unsuccessful attempts at gaining professional qualifications. His apparent failure to achieve good results may explain why he didn't tell his work colleagues or employers that he was taking up studying again. By keeping his Open University studies 'secret' they would not know if he did not succeed.

David was not alone in wanting to keep his studies secret from family and friends. Woodley (1993) points out that 'distance study allows people to study in almost complete secrecy if they so desire'. This is an advantage for those who are diffident or disaffected as

they can easily 'try out' an Open University course without telling friends, relatives and work colleagues. If they decide not to continue they need not be embarrassed.

David's reasons for studying.

David said that an article in a general knowledge magazine made him consider taking up studying again:

> *I found out you could be taught to remember, to learn. It didn't have to be a gift. ...then I got annoyed because I thought well, if teachers know, why they don't they teach you learning before they teach you subjects? Why isn't it a prime subject in school? There are proven methods to remember.*

David gave an example of a method of remembering: *'The ship left port, the port's always on the left'.*

David said he found the Open University television programmes on Saturday mornings interesting and enjoyable and this encouraged him to return to study so he registered with the Open University.

> *... it was put over in a way that you think 'I can understand that' and what I'd been reading in magazines, you think 'Hang on. I can remember these things. I'm sure I can improve myself' and from there I joined the Open University.*

David explained that he chose to do *Open Mathematics* for his first course because he felt he already had a grasp of mathematics so it would be an 'easy option'. It would also give him time to learn about learning:

> *... having read things about learning and remembering, that is what I'm more interested in. And actually using my brain. Now to do that you have to ... have to study something but I'm more interested in trying to improve*

myself, all aspects of me. Getting a piece of paper that says ... doesn't interest me.

I just wanted to learn about learning ...

David made many references to 'learning how to learn' in conjunction with 'remembering' and 'memory' in all three interviews. Perhaps he thought that 'learning' was about 'knowing' in the sense of recalling something when it was needed. David believed that there are techniques for improving learning and these can be 'learned' so he felt let down by not having been taught these methods and techniques. He might even have thought this could explain why he had not done well in examinations so far.

David seemed to want someone to tell him how to learn and what to learn yet later he contradicted himself by saying that he *didn't* like being told what to do, especially in relation to the audio- and video-taped materials provided for *Open Mathematics*. He seemed to blame his previous teachers, especially those who taught him at school, for not teaching him how to learn. On the other hand, when commenting on the calculator activities in *Open Mathematics,* he appeared to approve of the way he was taught mathematics at school;

... I came to learn maths that was what I intended to do and I just wanted to learn, the way I remember from school 'Here's your book, the trigonometry' not 'Oh can you press this button in the right order'.

It may be that David was at a 'traditional' school where teachers taught by 'transmission' rather than encouraging students to learn how to learn. Boaler (1997 p. 145) in her comparison of a 'traditional' and a 'progressive' school noted that in the 'traditional' school teachers did not see any real difference between transmission of knowledge and student understanding.

The apparently contradictory statements made by David could be explained in terms of their context. Blaming his teachers for not teaching him how to learn was about 'learning how to learn' whereas the reference to mathematics in school was about approval of the *teaching* of the mathematics. David did not seem to appreciate that his concept of 'learning how to learn'

was about improving memory. This was very different from the aims of *Open Mathematics* where learning mathematical ideas and mathematical thinking are important but at the same time the development of learning skills is stressed.

Although David seemed confused about the meaning of 'learning' with regard to *Open Mathematics* he was at all times consistent in his view that the process of doing the course was more important to him than the end result. He seemed to be learning-centred rather than product-centred.

David's various reasons for returning to study match three different categories of students' learning orientations as identified by Taylor (1983) and described in Beaty *et al.* (1997). David fitted into the personal category in two ways; intrinsic as he was interested in 'self-improvement' and possibly extrinsic in that he wanted to show he could pass the course. Wanting to 'use his brain' indicated an intellectual interest in the course, so fitting the academic intrinsic category.

David's pre-conceptions and expectations

David also talked about his expectations of the course:

> *I just decided that if you're not careful you stagnate ... what I've read and heard about the OU you can't stagnate because somewhere along the line they'll catch you ... and help you. You think, 'fine, great!'.*

David was expecting the course to help him improve himself and keep his mind occupied. It was unclear what he meant by 'they' in 'they'll catch you'; it could have been the system, the materials or the tutor (or a combination) but what *was* clear was that he wanted his studies and his learning to be supported in some way. This may have been especially important to him after previous failures.

> *Now I do believe that's what these courses are about – it's the whole point of learning, that you do retain some of the knowledge.*

Here David was more explicit about his idea that learning is about retaining knowledge and requires memory. It was not clear at this point whether he understood that acquiring learning skills was going to be a major part of the course together with applying knowledge and mathematical concepts and techniques to 'real' situations.

> *I was just expecting it to be a tutor on a video.*

This was a surprising observation given that, in my experience, few Open University television programmes screened in the period before David started *Open Mathematics* were in the form of tutor-led lectures. Perhaps he was referring to programmes made and shown many years before. He would find the programmes for the Mathematics Entry Suite to be more contemporary with mixed formats and hardly a conventional lecturer in sight.

Problems and blocks

David frequently referred to problems and 'blocks' even to the extent of saying he wanted them:

> *It's probably, I wouldn't say an insecurity sort of factor ... but for whatever reason I'm getting a bit long in the tooth now compared to some students, I think I want barriers.*

David may have wanted or even needed barriers in order to protect himself from failure. He objected to the self-assessment activities in particular and quoted as an example a question from an early assignment that asked for his ideas about mathematics and his previous experiences of learning. He said the question was designed to be:

> *... intrusive, as a ploy for the lecturer to glean information ...*
>
> *Personally I find some of these intrusion ... but at the back of my mind I would guess they are asking you to think ... um not on remembering but on becoming more with a philosophy of study. It makes you open up. It makes me open up to actually studying and what it is all about and not just remembering.*

So although David seemed to resent the intrusion, the invasion perhaps of his privacy, he was prepared to admit there was a reason for this, that learning is about more than just 'remembering'. By doing the self-assessment activities he would get more out of the course. He now had a different perspective on learning from that he had previously described. He seemed tentatively prepared to take on board ways of learning that were new to him though, as we shall see, this proved to be a slow and somewhat problematic process for him.

David's main 'block' was the use of the graphics calculator, an important part of the course as much of the mathematics is encountered through calculator activities. At an early stage in the first interview he commented that the mathematics itself had not caused problems but he was having a lot of trouble with the calculator. He said he used computers and sometimes a calculator at work but he objected to people 'worshipping' machines. He accepted that computers were 'wonderful' machines but he had problems when they were regarded as being more important than people.

> *I have a lot of psychological problems with machines like this.*
> *... computers are job stealers you see, ... I thought I was going to learn maths ... not be graded on my use of a machine ... My problem with the calculator is NOT the calculator's problem or the course's. I just have a big block on it.*

David's attitude to the graphics calculator was different from those of most other *Open Mathematics* students in my experience. Hodgkinson and Wright (1999) in their survey of *Open Mathematics* students found that most of those surveyed (68%) said the calculator motivated them to some or a great extent. This was confirmed by Hennessy, Fung and Scanlon (2001) who studied the use of the TI-80 graphics calculator by *Open Mathematics* students. Their study focused on the relationship between numerical data, graphs and algebraic equations, a topic that has often been problematic for students. The majority of

the students in their survey developed very positive attitudes to the calculator during the course despite many of them being apprehensive at the start.

Kissane and Kemp (1995) investigated student reactions to the use of graphic calculators in a first year undergraduate mathematics course in Australia. They used metaphors for calculator use. previously identified by Kissane (1995); laboratory, tool, teaching aid, curriculum influence, cheating device and status symbol. Their study revealed a gap which they filled with a new metaphor, that of 'nuisance' in the sense of getting in the way. None of these descriptions would appear to fit David's reaction to the calculator.

Much has been written about mathematical blocks (Buxton 1984, Evans 2000) but David did not report this kind of anxiety. He said he was not afraid of computers or calculators which he used at work. He linked his negative attitude / block to the graphics calculator to the wider society issues of technological advances which have resulted in fewer jobs. This reaction was unique in my experience of my own *Open Mathematics* students but David may well have seen the effects of this phenomenon in his workplace over the last twenty five years. This may be another indication (as in his description of changes in teaching / schooling) that David was resistant to change though at all times he was open about this resistance.

David linked calculators with computers and there is a wide field of research into 'computer anxiety', though research findings about negative attitudes to computers appear to be inconsistent. The 'condition' itself (if it exists) has been described as being multi-faceted and includes mechanical, functional and emotional factors. Worthington and Henry (1998) suggest the category of 'existential anxiety' evoked in users who consider the implications of computers for self, society and culture. This could possibly apply to David and his views of the effects of the increasing use of technology.

Although David chose to explain his resistance to the calculator in terms of 'job stealers' there may be other explanations. Soon after the first interview in which David described his negative attitude to the calculator I received an email from his tutor. This was unusual as we had agreed not to exchange information about the students, apart from the contact details at the start of the study. However she felt I should know the following:

> *"David arrived on my doorstep last night, clutching his TMA and ever so pleased that he has overcome his problems with his calculator and it's all thanks to you! Your discussion enabled him to understand his psychological barrier and he is now thrilled to bits with the TI-80."*
>
> *private email from David's tutor to researcher*

This episode illustrates changes in David's thinking and although he apparently attributed this to our discussion the transcripts give no clues as to how this occurred. It may be that just airing his views to another person enabled him to move on. This would fit with his statement in one of the interviews that talking helped him to learn. However it also raises the issue of the effect of the interview on the interviewee. Was I acting more in the role of tutor? David did not share this incident with me and I chose not to raise it with him, though he did volunteer comments in a later interview on his increasing confidence with the calculator:

> *... actually feeling more confident using the calculator... Although I didn't know how to use it I wasn't frightened of using it. You just hit the buttons once you know how or what. There's no problem there. I can see a great use for it and the quicker you learn how to use that calculator the drudge goes out of ... um ... all the calculations because once you know that you let the machine do that whereas to me I wanted to know how.*

David later gave a further explanation for his negative attitude to the graphics calculator:

> *...a lot of it was based on hitting buttons and that I just balked at.*

> *because you're using the machine as a route to the end instead of learning how to ...*

David recognised that the calculator was being used as a tool especially for calculations. He seemed to be making a general point here but unlike earlier when he used learning as 'remembering' he used it in terms of 'how to'. He was now prepared to learn how to operate the calculator so appeared to have overcome his previous resistance.

The only mathematical block reported by David concerned statistics, a subject he had failed on a previous course. Other barriers described by David were personal (intrusive questions in assignments and activities), psychological (not being able to pass exams) and technological (resistance to using the graphics calculator). David reported yet another barrier when using unfamiliar learning media such as audio-tapes in *Open Mathematics* but later we see that this was more easily overcome.

David recognised his 'blocks' as being negative and readily described them and gave reasons for them in some cases. He knew that he was resistant to change and that they appeared when he met something new.

> *Why do I have all these negative blocks? To me, all this is just doing is just in a way just opening me up because I recognise it's negative so once I can establish what all that's about, hopefully the positive will come out.*

David said he needed to confront the blocks (or the reasons for them) in order to work through them and overcome them. Later in the chapter there are examples of how David made changes in his learning.

David's awareness of his own learning

Throughout the interviews the negative comments made by David tended to overshadow the positive ones but there were several occasions when he showed awareness of his own learning. These are described here to give a more balanced picture of his learning.

David was aware of his style of learning:

> *I'm probably quite good at doing things practically but I'm short on the academic. What I have to do is to put them together.*

David recognised that *he* had to do this, probably a change from the kind of learning he had done previously particularly at school where he may well have experienced 'transmission' teaching.

> *I'm not someone who can just take it on board. I can, but I prefer to see and do. Another reason why I like the videos, you know because it's pictures, it goes in better for me.*
>
> *I do have great difficulty picking up a book and understanding it but if I see someone or someone talks me through it I can visualise it better.*

David was aware that his preferred style of learning was visual though he also found listening to be a good method for him.

David said he found the process of making notes 'painful' as he hated writing. The printed sheets provided in the course materials did not suit him and he rarely used them. The notes had to be to 'his spec' and :

> *... be something you can latch on to therefore it has to be in a format you can recall.*
>
> *...how I can get my brain to remember. You have to remember things, so why do I shut it out?*

Making notes was perhaps another example of David's preferred way of learning. An important reason for his making notes was to be able to remember though it is not clear *why* he had to remember. The course does not require students to memorise material but stresses the processes of understanding and applying.

> *At the same time you've got to learn, you've got to know 'why'. It's no good saying 'parrot fashion' because that's what they taught you at school and if you couldn't remember it you failed. You'd be better off knowing 'why' then if you get into a problem, you can think it through.*

David has now moved beyond 'learning as remembering', implying that if all you could do was remember there was a risk of failure. The way David expresses these ideas is an example of several occasions when he seemed to be talking in general terms rather than referring to his own personal situation.

David said that sometimes he learned from the answers. When stuck, he would go back to the books or to his notes and if still stuck he worked backwards from the solutions at the back of the units.

At other times he contradicted himself by saying that he didn't like to seek help (even from the units) and would rather learn from experience and struggle through than look at the answers. As with many of David's responses it was difficult to know whether he actually did what he said he was doing or whether he was describing an ideal way of learning that he thought others did or that he might aspire to.

Changes in David's Learning

David reported several areas where he felt his learning had changed; in using different media, in getting used to working with others and in managing time.

Different media

David said that using video-tapes and audio-tapes as learning tools was new to him and at first when he put on a tape a 'voice inside' him would say:

> *'Switch it off. This is my house you don't tell me' ...but now I'm actually embracing it, not rejecting it ...[I] actually appreciate how powerful it is.*

Perhaps this was another example of what David called 'intrusion'. He did not like being told what to do yet he showed that he could not only overcome this particular 'obstacle' but liked the new methods of learning provided by this distance-learning course.

Even so, David still preferred books because

> *...you can turn the pages back whereas switching the machines back and forwards isn't so easy.*

Working with others

David said that he appreciated the opportunity to work with others but the make-up of the group had to be right. He found the tutorials for *Open Mathematics* useful but he had stopped going to the tutorials for his next course, the Arts Foundation course, because he felt some students monopolised the discussion. However he loved the 'brilliant' sessions at the summer school for this course because it was a 'great' group of people.

> *You go in with the old school type attitude and then you realise you're talking to each other, you begin to push each other doing ...It is a unique studying tool.*

So David liked discussion when he liked the members of the group. Perhaps at summer school where students are together in close contact for several days he only had to overcome his 'block' or resistance once at the start, whereas with tutorials he might have had to do this at each tutorial.

David said that he was beginning to have enough confidence to ask questions in the tutorial rather than waiting for others to ask.

> *...this is part of a learning ...you think no, next time, I'm paying for this, I'm going to ask. This is what I want. They can always say no. Have the confidence.*

This is another example of David describing a 'barrier' he had to overcome, this time perhaps one of diffidence in discussion groups. This may well have been true in the particular situations he was thinking about but this was not the impression I got from our one-to-one discussions. In each of the three interviews David seemed to be very ready to give his views, perhaps because they were on a one-to-one basis.

Learning about mathematics in different contexts.

David said that one aspect of the course was particularly good, that of linking mathematics to real life. It had made him look at mathematics in a different way:

> *... so there is maths all right but it is taking you outside so they're making you think just a little bit differently, probably lightening the subject up... my old way is* [word not discernible] *... just follow this, learn that but no, now it's ... I do find it better ... but at least you can relate to it which is probably easier. If you can see something oh that's why ... an application and you think 'Yeah' so it's not just a book this is how it's applied.*

David seemed to have liked the aspect of *Open Mathematics* that links mathematics with real world topics such as those in the units *Maps* and *Earnings*. Perhaps, for him, this application helped mathematics to become alive. He referred to his old way of learning as 'follow this, learn that' and implied that a change had been made. Although he recognised that he was being asked to think in a different way he did not describe what his new way of learning might be.

Managing time

David said that doing *Open Mathematics* had 'got him going'. Although David didn't find the course planning sheets useful he came to realise the importance of managing time efficiently. He also learned that he needed to become more committed to study and would have to make some lifestyle changes, such as curtailing his social activities and spending less time helping others. He had enjoyed what he had got out of both the courses but he had not enjoyed the process of studying.

In saying that he didn't enjoy the process of studying David may have meant the time and effort he had to make to do it. He had enjoyed the content of the course.

Postscript

The year after *Open Mathematics* David did the Arts Foundation course.

> *... I just want to look at the arts side. I want to learn how to remember, I want to learn how to improve my life ... because in doing that and when you interact with other people, you can actually improve their lives, hopefully ...*

David gave similar reasons for doing this course as he had at the start of *Open Mathematics*, that is 'learning how to remember' and 'to improve his life' but this time he seemed to want to improve those of others as well.

David said he had registered for another Open University course but was unable to remember the exact title or code of the course.

> *Off the top of my head I cannot remember the number. Um it's not a foundation course but it is about understanding computers. Not programming as such but it's using the internet ...I paid my money, from the sales I've got to go and buy a computer.*

Although David used computers at work he did not have his own computer at the time he was studying his first two Open University courses. Earlier he had described his psychological blocks about computers because they were 'job stealers'. Now he was prepared to pay money not only to buy his own computer but also to study computing. David had made no plans for further study at the start of *Open Mathematics* but now he was embarking on a third course with some enthusiasm. Unfortunately I have no further information about David's study of this next course or any possible subsequent ones.

My resonances with David

I chose to write about David's resistance to using the graphics calculator because his attitude to using technology was very different from my own and that of most of my *Open Mathematics* students. Brought up in secondary school to do calculations with log tables, I used them happily having been taught their use 'by rote', though, to my shame, I never managed to master a slide rule. Perhaps if the principles by which they work had been explained to me I would have understood it better. However, I found the arrival of hand-held calculators, first basic ones then scientific and graphic, to be extremely exciting and not at all daunting. Later, exploring the facilities of computer graphing packages such as *Autograph* kept me happy for hours. Yet, as a tutor, I have had to be careful and recognise that some students have problems with acquiring and using a graphics calculator. When a student has reported a dislike of the course calculator, I have had to find out which particular 'barrier' needed to be overcome; be it financial, or the assumption that a computer will do the same job, or a difficulty in seeing the screen (especially the small screens of the initial TI-80s), or even, like David, an unwillingness to use technology at all.

I was also intrigued by David wanting to 'learn about learning' but linking this mainly with 'remembering'. Yet *Open Mathematics* stresses the skill of learning in terms of understanding, using and applying. Rarely do facts have to be remembered. It helps if key

presses on the calculator can be memorised though these are usually soon gained by practice. When I returned to learning mathematics at undergraduate level, some twenty years ago with the Open University, I was delighted to find that learning 'parrot fashion' (David's words) was *not* required. Not only was there a handbook for each course which contained all the relevant formulae, but I could take it with me into the examination, thus leaving my brain free to think about the topic or question and then use and apply skills and knowledge.

Relating David's story to the original research questions

David's rather complex character and his tendency to give a multitude of opinions provided a lot of data, only some of which is reported here. The summary answers to the original research questions may not be as reliable as those for other students in this study as it was not always clear which of his responses applied to his own practice and which were general statements.

1. To what extent was David aware of his own learning?

David was intensely aware of his own learning both when it went well and when it did not. He was aware of his failure to master certain things and his reluctance to try new ones. He was especially aware of his limitations and 'blocks' to his learning but knew that sometimes he created them himself. He wanted to be supported in his learning yet did not like anything he regarded as being intrusive and said he didn't always like to seek help. David said he liked to 'learn by doing' which for most people might mean learning from mistakes, yet he was diffident and insecure and afraid of failure.

Working with others was an effective way of working for him, but only when he liked the make-up of the group. He was aware that he preferred visual and auditory ways of working

rather than reading text and after a shaky start he came to appreciate the variety of media for learning provided by the course.

David wanted to know about techniques for learning in the sense of remembering, yet he said the process of learning was more important to him than the product.

2. Was David aware of any changes in his learning during the course?

Despite not doing the learning activities and his reluctance to try anything new, David seemed to be more aware of his own learning and changes in it than the other students in this study. This may be because there were more changes to report. It may be that David was more willing to share his ideas and opinions with me as interviewer.

David was aware that his confidence had grown over his first two years of studying with the Open University. He was more prepared to work in a group situation and to ask questions at tutorials. At first he was suspicious of the learning media provided by the course which was new to him, but in time came to enjoy the audio- and video-tapes. To an extent he overcame his resistance to the graphics calculator.

David was aware that he had overcome some of his fear of failure which had affected his previous studies. The delivery of mathematics through real-life contexts had been a successful way of bringing him back to study. It had helped him to look at things differently and even recognise that he might change from his old way of learning or of being told 'follow this, learn that'.

David also learned that for successful study he needed to give more time to it and give up some other activities.

3. How did David use the activities designed to help him how to learn?

From the interview transcripts there was little evidence that David used any of the learning activities provided in *Open Mathematics*. He said he did not do them and this may well have been the case. Even if he read them or thought about them he appears not to have written any responses to them. He strongly rejected the self-assessment activities as he felt they were intrusive.

4. Did David use reflective type learning?

During the interviews David reflected a lot in terms of thinking about issues arising in our discussion. He made many statements, and put forward explanations and opinions. He did not introduce the word 'reflection' but near the end of the second interview I asked him whether reflecting and reviewing were processes he used. He said he didn't have time to reflect by the end of the course but he found 'reflection coming through the whole study period' and gave some examples:

> *You see a rainbow in the sky ... you suddenly 42 degrees. Why? You've remembered something. Now that would be reflecting.*
>
> *... the reflection is a luxury. It's a necessity but it's a luxury. You sit down, you do your studying and you think 'Now what have I done?.*
>
> *... after the paper has been sent in and the euphoria of meeting the date ... then you sit back and reflect ... Ah, yes, that was a good course!'.*

In the first example David used reflecting in connection with recalling a fact. In the second he implies the stages of thinking and reviewing as given in Unit 16 (Open University 1996c) but makes his comments in a general way rather than a personal one. This second example also shows his tendency to produce what could be seen as contradicting ideas such as necessity and luxury. The third example is one of looking back at an event, making a judgement on it but not explicitly using it as an opportunity for further action.

In the third interview some of the R statements (Appendix D) provoked long complex responses from David with much repetition.

> *I reflect a lot of the time, because that's how I'm remembering, because that's how I test myself. ...I have to reflect to prove that what I'm doing to myself is worth it ...*
>
> *It says 'I didn't do the reflecting bits because they're personal'.* [rN in Appendix D] *I'm the reverse. Because they're personal I do do the reflecting.*

In this first example, David used reflecting in terms of his personal achievements in life rather than in improving learning. In the second example it might seem that he contradicts earlier statements about some of the activities being personal so he didn't do them. It would seem that he used reflection on his own terms, when he wanted to do it and not when he was asked to as part of the course. Boud's assertion that the process of reflection involves feelings would seem to fit with David's experience (Boud *et al.*1985). They said that attending to feelings is important and learning is improved by the student exploring the beneficial aspects of experience as well as exploring and removing feelings that would obstruct learning.

What I learned from David

David's story produced aspects I had not considered in depth before. One of his main reasons for doing *Open Mathematics* was to learn how to learn, not in the way the course advocates but in learning as remembering and recalling information. Although students are encouraged to communicate with their tutors and tell them why they want to study this particular course, they may not do so, or may tell the tutor what they think they want to hear. In David's case he felt that divulging information like this was an invasion of his privacy.

I learned that some students have blocks to their learning, sometimes, like David, apparently creating their own obstacles. I have not been aware of any of my own students who have put up their own barriers (though they may have done) but I have met students who have a fear of failing and failing mathematics in particular. Students like these may not always be easy to guide and it needs a sensitive approach from a tutor. I have learned about apparent contradictions from David but have not always been able to make sense of them; for example, despite putting up barriers and resisting learning activities David wanted support from the course and his tutor. He wanted to be taught but also wanted to do things his own way.

Despite all the problems, blocks and misconceptions, I learned that it was possible for David to overcome them and complete the course (though on his own terms!) and enjoy it.

CHAPTER 5 HELEN'S STORY

I'm doing studying ... just because I wanted to do it.

Just to fill time and just to keep my mind occupied.

This chapter describes the experiences of learning of a student who had previously studied vocational courses as an adult. She completed *Open Mathematics* but, so far as is known, has not gone on to study other Open University courses. Aspects of her story give opportunities for examining some of the issues that cause students to withdraw from a course or postpone their studies. This chapter looks in some detail at some of her beliefs and approaches to learning at the start of *Open Mathematics* and at changes that took place during this course.

Background

Open Mathematics was Helen's first Open University course and her first undergraduate course though she had previously taken vocational courses (BTEC and City and Guilds) in Fashion and Design and in Secretarial Studies. Three years before studying *Open Mathematics* she said she wanted to learn how to use a calculator so took GCSE mathematics at a local college. Helen said she liked working with figures and used them daily in her full-time job where she created databases and designed spreadsheets in Excel to produce costings. Helen felt that she was 'all right' with mathematics as it was about facts but was not confident with English which she described as like 'plucking something out of thin air'.

While Helen studied *Open Mathematics*, the other members of her family were also taking courses; her daughter at a tertiary college, her son in his second year of 'A' levels and applying for university entrance. Helen's husband was studying the Arts Foundation course with the Open University. In the first two interviews she expressed no career or work-

related reason for studying mathematics but did give a particular reason for starting with *Open Mathematics* rather than any other course:

> *I must admit that when applying for the course that was the major thing for applying 'cos not having an exam ...I couldn't have coped with the exam at the end ... I wouldn't have had the time to study for the exam ... that was quite a selling point... for that particular course.*

Helen implied that the absence of an examination was very influential because of the time needed to prepare for it. She may not have appreciated that preparing and completing the End of Course Assignment for *Open Mathematics* could take the same amount of time, possibly even more.

In the third and final interview, when Helen was no longer taking an Open University course, she described her general reasons for studying:

> *I'm doing studying just because I want to do it. Just to fill time and just to keep my mind occupied.*

Unlike many students Helen did not choose a particular course to further her career or help her gain skills and knowledge for work. Her use of the word 'just' might indicate that *doing* a course was the important thing, not the content or the subject area. However it should be said there that 'just' was a word Helen used frequently, usually in the sense of 'only', but also sometimes for emphasis or to mean 'nearly' or 'recently'. These were my interpretations, of course, and it was during the transcription process that I noticed the frequent use of word.

Helen may have wanted to do the course to avoid being bored or to keep up with the rest of the family. She described her skills in mathematics as being 'all right' so this subject might have appeared to be a familiar and safe subject to study. She may have chosen an Open University course rather than enrolling at a local college because her husband was already an Open University student. By following *his* path and keeping him company (so to speak) she may not have sufficiently considered whether distance-learning was appropriate for *her.*

In terms of Taylor's categorization, (1983) Helen's purpose in studying was closest to that of a 'personally orientated student', one who has the aim of 'broadening or self improvement'. Beaty *et al.* (1997) maintain that for students in this category the particular course they choose to study is almost irrelevant and is often made by elimination of other courses.

First interview

Helen was asked to think about her learning in general at this half way stage of *Open Mathematics* and to comment in particular on any changes in it since the start of the course. Her responses mainly related to organisation of study.

Time management

Helen followed her first reply *'Timewise, quite a bit'*, with descriptions of various problems she had encountered, such as finding enough time for study and making a workable timetable. She made comparisons with her previous experiences of adult education:

> *With some of the other courses I've done, it's been at night school... you tend to spend, two hours, four hours or whatever, just doing whatever it is you're studying because that's all you can do. When you're at home, you've got other distractions and other things and then organising yourself is the most difficult thing ...*
>
> *...when you work out I'm going to do this, this and this, I find you can't stick to it, so I do it to fit in around myself day by day. In the first TMA you had to write a letter or something wasn't it and I think I wrote in there that I fitted it (studying) in around family and everything else.*

Helen appreciated that learning takes time. For a college-based face-to-face course much of this time is externally fixed. For a distance-learning course most of the 'time slots' needed for

study are allocated by the student. The time has to be found from somewhere and it is easy to put other things first.

Helen did not have a regular time for study nor did she work to a particular pattern. Sometimes she studied each morning before going to work and for a short while she also tried working in her lunch times but she found this to be ineffective as she often had to repeat the work later. Rather than plan ahead she took opportunities for study when it fitted the family's needs so, for example, when her husband was working shifts she studied in the early mornings and evenings to fit in with his timetable.

Helen implied that, before *Open Mathematics*, college work and study were separate from home life. Now she realised that all the study for this distance-learning course had to be fitted into her personal life but for Helen, family matters and other events came first before her own study.

Open Mathematics includes activities designed to improve students' own learning, one strand being about planning work and setting targets.

> *But when they ask you in advance before you start this module, plan, I think, well no, I don't know what I'm going to be doing for the next two weeks so I take the time when I can.*

So Helen didn't use the planning sheets or make written timetables and seemed to be resistant to the advice given in the preparatory materials and early course units about the importance of planning. This may have been because she had no particular aim except to 'fill time'. Yet it would seem that she did not appear to want to identify or find this time in advance.

The experiences of *Open Mathematics* students were recorded by Hodgkinson and Wright (1999) in research designed to evaluate the impact of the Key Skills elements in the Higher Education curriculum. Some 90% of the students in the survey said they had completed at least some of the planning activities, the rest had done none. Although there was a mixed

response about the usefulness of these activities, by the end of the course almost three-quarters of them felt very or fairly confident about using their plans.

Helen's second comment about problems of planning related to her busy work and family life. It is not known whether the other family members actively supported her studies but they were students too, so she was living in a learning environment. Helen's problem with allocating time was not unusual, though in my experience most Open University students *do* find the necessary time, some being more successful than others. For example, one of my own *Open Mathematics* students (DH) studied from 9.00 p.m. to 10.00 p.m. each weekday night with extra time at the weekend when an assignment was due. By spending time with his family immediately on his return from work he felt able to take time later in the evening for his own study.

It could be argued that this problem of allocating time is more difficult for women, yet again, in my experience, most find a suitable way of working. Another of my own *Open Mathematics* students (CH) in a similar situation to Helen with a full time job and a family told me she was grateful for the support and encouragement of her family. However an important turning point for her was the realisation that if she was to succeed she had to be selfish and allocate specific private study time for herself. It may be that Helen felt she could not be 'selfish' in this way.

Blaxter and Tight (1994) interviewed part-time degree students at Warwick and Coventry Universities. Many of them made comments about the use and ownership of time. Most of the women had family, personal and work responsibilities which were of primary importance to them. They organised their studies around these commitments but often felt pressure to maintain their overall performance in *all* of their roles. Somehow they had to find study time within their 'own' time, for example when children were at school or asleep and many reported having to give up activities such as leisure pursuits or voluntary work in order to do their courses.

Organisation

After describing her problems with finding time for studying, Helen was keen to tell me the way she organised her Learning File, using dividers for each section to group information together. She filed the blue sheets (handbook sheets for definitions and explanations) in one place rather than in the separate units, so that all the formulas and definitions were together, making it easier for later reference.

> *And as I'm working through each bit I think ' I'm going to need that, or information from there to be able to answer that question ' and I mark them down and I write the page numbers, I write it in my TMA question and I write the page numbers and the Unit number of where I can refer back to to help me out.*

Helen showed that she could think ahead from process to product. She sorted and selected material and marked sections for use when completing assignments. This suggests that her strategy was that of a TMA (Tutor Marked Assignment) Dominant student (Lockwood 1995) rather than a TMA Aware student and comments made later interviews confirmed this.

In her previous studies Helen said she had 'jotted' notes in a small notebook with headings for different subjects. She said that her method of note-taking had worked especially well for examinations because they gave her a 'heading' from which she could later recall or reconstruct the details when revising. She said they could be as brief as she wanted as they were 'for her eyes only'.

> *... if there was anything that was long-winded in some of the books I'd take a note and I'd put a little bit on the end 'See Book number page so and so' and I would have highlighted that particular bit in the book and I could go back to it and it was quick and easy to find.*

Being organised or being seen to be organised was important to Helen. Her notes were facts or reminders which she could refer to when she needed to retrieve information. The form of

the notes seemed to be similar to those made for her previous vocational studies and GCSE mathematics. At this point in *Open Mathematics*, her only reason for making notes was to be able to access information at a later date particularly for assessment purposes. Helen did not appear to be putting mathematical ideas into her *own* words in writing or otherwise, or to see the importance of this process. Her notes appeared to be reproductions of the text, the parts she saw as being useful references while preparing for assessment.

Helen may not have seen the point of doing the learning activities, perceiving them to be difficult, boring or unnecessary and she said she was perpetually short of time, despite one of her original reasons for study being to 'fill time'. Helen regarded her notes as being private and said she did not want anyone else to read her notes and, of course, by *not* doing the learning activities no-one would ever be able to read them. Helen may have misunderstood the purpose of the learning activities which were mainly designed for students to reflect on progress, to relate new work to that previously studied and to ensure current work had been well enough understood before moving on to the next section. She may have had the misconception that someone other than herself would read the contents of her Learning File whereas this was not the case, though for each tutor marked assignment she was asked to answer one question based on these learning activities. Examples of such topics include; experience of mathematics and learning before starting the course, assessment of skills during the course and making a plan for tackling the End of Course Assessment.

Helen said she deliberately left out some activities:

> *You get to the activities, especially if you're getting short on time, you see these activities and you think 'Oh, I'm not going to need that ... '*

Helen was being selective in her choice of which activities to do but the decisions seemed to be driven by time considerations rather than whether a particular activity would help her in her learning. From her answers in the interviews at this stage of the course Helen would appear to have had a surface approach to learning (Entwistle 1997) in that she felt under pressure and

put more emphasis on memorising, note-taking and recalling information than on understanding.

Second interview

In the first interview Helen gave short answers to questions about learning with replies focused on problems she had experienced due to lack of time. In the second interview, in an attempt to move beyond these aspects, Helen was asked about 'learning' and 'studying'. Did she regard them as being the same or different and if the latter, how were they different?

> *I would say the two go together. The studying enhances your learning ... but you need the time to study to be able to take in what you are supposed to be learning.*

Time management

Helen amplified this by returning to the issue of time management, explaining that earlier in the course she had experimented with different lengths of study, sometimes working for periods of an hour, at other times just half an hour. As the course progressed and the work became harder Helen found that she needed even more time that she hadn't planned for so she was always struggling to catch up. Half way through the course a batch of material arrived late which, she said, resulted in her becoming several weeks behind schedule so for the second half of the course she felt that she was playing 'catch-up.' As the work was now becoming much harder the problem of lack of time was exacerbated and she realised that a one hour study session was no longer enough.

> *... as time went on through the course I think I needed more time to study in, to be able to learn as opposed to a shorter time. ... The fact that I was always having to catch up on work. I think the time scales between assessments, the further on you get, get shorter because you then you have*

to study more to understand. You've got more work to take in. You can't skip over so quick as you can at the beginning. I suppose it depends on your depth of knowledge when you start.

Helen here implied that you need time for study and this time then enabled learning but she gave no indication of how this time might have been used more effectively. Yet again the emphasis on finding enough time dominates her description of her learning though the late arrival of the materials did not seem to affect the other students in the study. It seemed as though she would have liked to find the right conditions for study, to be a 'strategic learner', (Entwistle 1997) but could never quite manage it. She was aware that she needed to adapt her study in the sense of taking a longer time to facilitate understanding. She knew that working through material superficially was not enough but she did not indicate how she was going to achieve a deeper approach to learning. Possibly the *Open Mathematics* 'how to learn' activities she had earlier rejected or resisted might have assisted in this.

Changes in learning

Later in this interview Helen was asked whether she had learned anything about her own learning as a result of this course. Yet again she commented on lack of time but soon expanded this to describe changes in her approach to studying as the course progressed. For the first 'half a dozen' modules, Helen said she had 'skipped' over the materials, especially those that asked her to 'explain something in her own words' and did not engage in many of the activities. Later she found that she had to change:

But towards the end you had to read, you had to read nearly every page, I mean you just can't get out of it. And I got to a point towards the end where I was looking for something [so] that ... I could answer the question and then I could skip to the next question so I wasn't taking in what it was I was learning. I basically looked for the information to answer a question. Yes, I couldn't have done an exam on it for the life of me I couldn't tell you what it was I did.

Helen seemed to have become an even more TMA Dominant student with her main aim being to get the answer to a particular question and as the work got harder it took longer to find it. She also knew she should be 'taking things in' in terms of understanding, a deeper approach to learning. She appeared to find the process of learning and preparing the solutions (answers) to questions too much to cope with at once.

In response to a question about her style of learning Helen said that when reading through the course texts, or indeed any book, she found it difficult to go on to the next paragraph in the text until it had fitted in with the one before.

> *I have an awful habit, if I don't understand something... I can't read on I have to keep going over and over or doubling back so that it all fits into place before I can move on.*
>
> *I mean sometimes I know I should do because it might jog something back into place but I found that was quite bad in some of the books, the explanations.*
>
> *I like to understand what it is I'm supposed to be ... and why I'm doing what it is I'm doing.*

Helen's description of not being able to move on as being 'an awful habit' might indicate that she was using 'habits' used previously. She may have been unwilling or even unable to change her methods. It would seem that not being able to 'read on' was inconsistent with Helen's earlier remarks about 'skipping' material due to lack of time. With the mathematics she said she would not 'go on' until she had mastered it but she seemed happy to miss out the bits about learning how to learn perhaps unaware that these activities might introduce her to new, more efficient strategies for tackling difficult concepts. Although she was still putting some blame on the course materials arriving late or not having clear explanations, she was also aware that deeper involvement was required by her. She was almost apologetic about having to go back over passages in the text though she also put some of the 'blame' on the materials in the units. Again this difficulty in making sense of new ideas indicated a surface approach to learning but it appears that she was trying to fit new bits into old ones, showing a move into a

deeper approach to learning e.g. relating ideas to previous knowledge and experience (Entwistle 1997) or at least an awareness that this was what she should be doing.

The effects of the course calculator on learning

Helen was asked to give an example to illustrate her comment about some explanations in the books being 'quite bad'. She said she had been embarrassed when her son, who was studying 'A' level mathematics, asked her questions and she could not answer them.

> *He's working things out on paper and I can't do them, because we just used to pump formulas into the calculator and it will produce an answer... they only gave you the basics on paper and then lots of the things were calculator based ... and you work from there.*
>
> *...you put the formulas in Y = and it produced you nice little graphs with your little lines and everything on and you could read off everything from the tables from there but if you had to do it yourself it didn't tell you how to work it all out manually. It was aimed at the calculator as opposed to manually.*

Helen was very positive about the usefulness of the calculator. She could follow the instructions and carry out the given key sequences but she was not comfortable with her lack of understanding of the underlying mathematics. She even took the calculator to work each day where her colleagues asked to try it out. However she said they soon found they did not know how to operate it and passed it back to her so she ended up 'having to do all the work for them'.

Helen didn't attempt to teach them how to operate the calculator themselves perhaps because she was still not confident in the processes used. She deliberately chose to do the calculations for them - perhaps enjoying the feeling of knowing more than they did. She regarded her acquisition of skills in operating the calculator as being learning in the sense of 'learning how to' rather than learning about the mathematics.

Helen said she had real concerns about her lack of understanding of what was happening when she pressed the keys. Although she could often work through and get the required solution there were times when she thought:

> *...why is it they've done that and why's that gone in there and why has that happened here?*

She explained her difficulty by comparing this new way of learning with what she called the 'old' way she had been used to at school, more than twenty years ago, where everything was worked out on paper.

> *... it used to take you reams and reams of paper to get to an answer where now its done in minutes. I suppose at the back of my mind it was thinking that after all that hard work we used to have to do and being able to work things out and you had figures all over the place - you don't need it now.*

Helen felt that too much of the course was based on the calculator and said that the calculator books gave instructions about which keys to press but this did not help her with understanding the concept.

It is almost as if she felt cheated when the solution just appeared without explanation or effort. She associated getting to the answer as involving hard work and written calculations. Helen liked to be able to operate the calculator, particularly at work. Her comment about only being given the basics on paper might indicate that she did not work through the calculator activities in detail thus missing out the explanations of the mathematics. The calculator activities have been designed to be integral with the course and most students feel that this has been successfully done.

Most, but not all, of my own *Open Mathematics* students have found the graphic calculator to be an exciting part of the course with the calculator books being easy to follow. Some,

like Helen, found that the use of the calculator tended to mask the underlying mathematics but most of them have found the opposite.

Hodgkinson and Wright (1999) in their survey of Open Mathematics students found that almost three-quarters of them found the calculator very or fairly easy to use. A slightly smaller proportion (68%) said that the calculator motivated them to some or even a great extent. In contrast to Helen, 86% felt that to a great or some extent the calculator enhanced their understanding of the mathematical content of the course. One notable exception to the majority of these students is David (another participant in this study) whose adverse reaction to the use of technology in general, not just the graphics calculators, was described in the previous chapter.

Reflection

Helen was asked how she used section 3 of the final Open Mathematics unit Rainbow's End (Open University 1996c) which was designed to help students prepare for the End of Course Assessment. It invites them to pull the different threads of the course together, review progress and reflect on how they see and think mathematically. For the first time she used the word 'reflecting' by saying that she always used to skip the 'reflecting bits'. Now that Helen had introduced this word 'reflecting' I asked what she thought the word meant:

> *... the reflecting bits. These come as a personal thing and I always used to skip them out which basically comes down to the yellow sheets which I always missed out.*
>
> *Well, looking back, looking back over your work and whether good or bad and either criticising yourself or just to...on how you're working. . . the first bit 'presenting your work' and to reflect on your progress I mean to look back on how you've presented your work through the course. I just used to*

think 'well I need to do this' and I would just get the information and I would forget whether it was ... I never looked back, only for questions.

Helen was unusual amongst this group of five students in that she used the word 'reflecting'. She said she objected to the 'reflecting' activities as they were personal, in the sense of 'private' but most of them were aimed at helping students improve their learning and were not expected to be shared with others so would be private anyway. Perhaps she wasn't prepared to give the time and energy to these activities; she certainly was not willing to share any responses (if she had made them) with others. Helen makes the distinction here between going back over work in order to collect information (which she did) and going back to assess progress and learning which she says she did not do.

Third interview

Helen was the only one of the five students in this study who did not continue studying with the Open University after completing *Open Mathematics*. She said she had registered for MST121 *Using Mathematics* for the following year but was dismayed when the preparatory materials arrived soon after she had submitted the End of Course Assignment for *Open Mathematics*, just when she thought she was going to get a break from studying. Although she did some work on the preparatory materials and submitted the first computer marked assignment she began to realise how much of *Using Mathematics* required the use of a computer. She explained that her son needed a computer and he should have priority so now 'lack of access to a computer' became her main reason for withdrawal from the course rather than 'lack of time'.

This was perhaps another example of family coming first though the reason given for not continuing, 'lack of access to a computer' was somewhat puzzling as Helen had earlier reported that the family already had two computers. There may well have been other reasons which she chose not to share.

Despite not having done a course during the year after *Open Mathematics*, Helen was very willing to be interviewed for a third time. Her answers in the second interview had been longer than in the first and this time her answers were even more considered and apparently thoughtful in nature.

A possible reason for this was an increased familiarity with me; we had discussed matters of learning twice before but she may also have liked the more structured nature of this third interview, where much of the time involved sorting the collection of statements made by all the five students in the previous interviews.

Early in the selection process for the M statements (relating mainly to *Open Mathematics*) she picked up the two statements

I learned how to learn

and

I learned how to study

and appeared to puzzle over them:

> *They're similar but they're not. The 'how to study' I think was more to do with in some ways planning, managing your time ... If you haven't got the time you can't do the learning. Because I think you need the time to be able to concentrate and take it all in. ... as time went on through the course I think I needed more time to study in to be able to learn as opposed to a shorter time.*

These comments agreed with those in the previous interviews but this time she added the word 'concentrate', another indication of awareness of the need for deeper learning though Helen still focused on the organisational side of the course rather than the processes of learning.

At this point Helen was asked how she knew when she had learned something:

Because you can get a result at the end.

She explained that this meant answering the question and getting the same solution as the back of the unit. As in the second interview she described how she achieved this:

> *I mean how I work, even now, if I don't understand something I have to keep going over and over again to understand why they've done whatever it is they've done and what they're explaining for me to do. And if I can't understand that then I would have to keep back-tracking through other books to find more information out. The obvious thing to do was usually to go forward but you tend not to go forward in case you get a bit more out of your depth and get stuck ...*

Perhaps repeatedly going back over material in the units took up more time for Helen than for other students. She seems dependent on the explanations in the units and used time to 'back track' rather than sit back and reflect on or reconstruct what she was learning. She was reluctant to go on to new work and even seemed a little scared of getting stuck, an understandable feeling though 'getting stuck' can be a useful way of learning mathematics. As before, this description of her learning, not being able to move forward, conflicts with the times when she said she 'skipped' material.

For the third set of statements, R, Helen picked out the two statements

Reflecting means looking back over your work

Reflecting on progress is looking back to see how far you've come

and said:

> *Oh these two are the same. I didn't look back over my work. I only went through just to find the information I needed to answer the question at the end.*

... my reflecting on progress was how big my file had got...

Helen said that she did not reflect on her learning while studying *Open Mathematics* and the way she chose the R statements (Appendix D) would seem to confirm that assertion. The statement

Reflecting means looking back over your work

had originally been made by Helen herself in the second interview so she had some idea what reflection might mean but still she said she did not reflect. However, comparing what she said about her learning with the three aspects of reflection as given in the final unit of Open Mathematics (Open University 1996c p. 27), it would seem that there is some evidence that Helen did *think* about the work she was doing. To some extent she also *identified* the work she had done but only in relation to an end product for example, the solution to a mathematics question in the units or a sample of work for the End of Course Assessment. There was little evidence that she made generalisations or applied skills and techniques to new situations.

Reasons for discontinuing study

The issue of lack of time is not unusual. Hodgkinson and Wright (1999) found that *Open Mathematics* students gave 'not enough time for study' as the most frequent reason for withdrawal from the course (33% of respondents). More generally, in an earlier survey of 'dormant' Open University students (those not currently taking a course) Woodley (1993) found the most common reason for giving up or postponing their Open University studies was 'lack of time caused by other demands at home or at work.'

Scott, Burns and Cooney (1996), in Australia, researched a sample of 118 mature female university students with children to find out why they discontinued their studies. They suggested three major reasons for 'drop-out' amongst women, though two do not fit closely

with Helen. The first was a combination of lack of support from family together with difficulties with money and sometimes a lack of knowledge or skills expected at university.

Helen appeared to have support from her family though she may not always have accepted it and paying for the course did not seem to be a problem. However the skills and discipline required for distance-learning at university level may well have proved just too challenging for her.

The second reason arose from those studying non-traditional subjects such as Economics, Business or Law and they cited lack of academic support or staff hostility as a reason for leaving. Mathematics was not included in the list of these subjects and Helen reported good support from her *Open Mathematics* tutor.

The third reason was connected to a student's age. Younger women with younger children were likely to leave because of family, financial or child-care related reasons whereas older women cited practical difficulties or dissatisfaction with the course.

Helen's practical difficulties with available study time, whether perceived or real, and her practice of putting her family first match the reasons for both the younger and the older women in this Australian survey. Although I did not know Helen's age she probably came between the younger and the older women category.

Postscript

A year later, Helen said she considered re-starting *Using Mathematics* but finally decided against it. There was now only one computer at home as her son had taken the second one with him to college. She went to an Open University course choice meeting where she became interested in a Science course about the Human Body. As this was a second level course, she was advised by an Open University representative to do the Science Foundation Course first. She did not want to do this so decided not to continue studying

with the Open University. Instead Helen took a vocational course at a local Further Education college and learned skills for doing local voluntary work. As far as is known, Helen has not registered for any further Open University courses.

Perhaps with Helen, it was not a case of actively discontinuing her Open University studies but a lack of real interest in or reason for pursuing an academic course. Helen's surface and strategic approaches to learning (Entwistle 1997) rather than the deeper ones usually needed for university study may have compounded her problems. The vocational course she chose to do after *Open Mathematics* suited her more practical inclination and her preference for working in a group in a conventional college setting. Helen sent me a letter after this final interview saying she had changed her job and now managed spreadsheets which were:

> *... 20 deep and all inter-linked, so MU120 has helped me and I progressed on from Question 'F' in interview 3.*

Helen was referring here to the statement *'I'm more confident in my mathematics now'* so perhaps doing *Open Mathematics* had given her a sense of achievement in mathematics knowledge and skills even if it had not developed her learning skills. It may have been that the more demanding tasks required in her work enabled her to *'keep her mind occupied'* so that she no longer needed to study in order to *'just to fill time'* (see chapter heading).

My resonances with Helen

In all three interviews the experiences Helen recounted seemed to be quite negative. There *were* some positive moments, for example when she told me she loved algebra, but in the main I have chosen not to explore them. Instead I have looked at problems that may arise for students and how they may react when studying and learning became difficult. In my own studies I was unprepared for such difficulties. Up to the age of eighteen my attitude to

study was straightforward: just get on and do what was required. For me, understanding and applying scientific and mathematical ideas seemed to be relatively easy. Going to university was expected of me by my family and by my school. Studying Chemistry was more a matter of continuing with a familiar subject rather than of any particular interest or talent. I did not know that there were theories about learning so had no suitable skills to apply when I had major problems with the mathematics courses I was required to do in the first year. I knew there was a gap between my skills and knowledge (gained from just one 'A' level Maths for Science course) and those assumed by my lecturers but I had no idea how big the gap was or how to close it. This feeling of panic and inadequacy has proved useful when working with students who find mathematics difficult though I can't say I always know how to help them.

Relating Helen's story to the original research questions

Each of the original research questions is discussed here in turn.

1. To what extent was Helen aware of her own learning?

Helen mainly considered her own learning in terms of organisation of her study materials rather than the process of learning. She stressed the importance to her of arranging the course materials and her notes so that information could easily be retrieved. In terms of organising time for study she found this very difficult and said she constantly felt under pressure due to lack of time. This conflicts with her reason for doing the course, to fill time. It would seem that finding the time was not a priority for her.

Helen knew that her understanding of some of the work was not always robust. She was aware that she needed to go back to previously studied material and was frustrated when she did not understand something or found it too difficult. She was also aware that she did

not always understand the connection between the operation of the calculator and the underlying mathematics.

2. Was Helen aware of any changes in her learning during the course?

Helen was aware that as the material became more difficult she needed more time for study and as she was short of time she 'skipped' things she did not feel to be necessary, in particular the learning activities. She also said that sometimes she found that reading or re-reading was not enough to understand something and said she had an 'awful habit' of not being able to carry on if she did not understand something. These two statements could be seen to be contradictory: she often skipped material but also she was not able to go on. On further consideration it would appear that Helen was missing out the learning activities because she did not think they were relevant and concentrated mainly on those parts of the course texts that would directly help her with assignments. It may have been just these parts of the text that she was referring to, the ones she had to spend time on in order to understand.

Rather than being aware of many changes in her learning, Helen, in the interviews, seemed to refer to study methods she had used before, for example making notes for recall and revision purposes. In general she seemed to have resisted the suggestions made in the course materials to try activities designed to change, develop or improve her learning.

3. How did Helen use the activities designed to help her how to learn?

Helen said she did not do these activities, not even the planning sheets which were the most straight-forward ones. It is not clear how she used the learning activities associated with the calculator material.

4. Did Helen use reflective type learning?

Helen said she did not use reflection. She said that the 'reflecting bits' were a waste of time and she was not prepared to share her personal thoughts. She seemed to connect reflection solely with self-assessment of progress rather than using it for learning.

What I have learned from Helen

Helen's story has made me think about the relationship between studying and learning. Helen stressed her organisation of study in the sense of arranging her course materials to help her look up items she might need for assignments. She was keen to describe problems she had in finding time for study. In the second half of the course she said she was concentrating on finding the relevant information for assignments, TMAs and the End of Course Assignment. It was more difficult to find out about her learning, her methods, styles and strategies. I was left with the impression that Helen wanted to be a student in the sense of the status that came with it and the satisfaction of successfully completing assignments. She did not seem to be interested in being a learner in the sense of understanding concepts and applying them to new situations.

CHAPTER 6 NEIL'S STORY

'When the sun is out it's hard. It's all right when it rains.'

This chapter describes the experiences and ideas about learning of a student who had previously studied several mathematical and engineering courses as an adult at a local Further Education college. He had also taken distance-learning courses in Physics and Mechanics with the Open College but *Open Mathematics* was his first Open University course. Some comparisons are made between these different kinds of courses, all of which were paid for by his employers.

Background

Neil worked for a large company as a mechanical engineer but wanted to improve his mathematics in order to change to electrical engineering. He chose to start with *Open Mathematics* and then did *Using Mathematics* MST121 the following year. He felt these courses would act as a 'springboard' to the more difficult Open University courses he hoped to take in the future, possibly 'going all the way to get a degree' in six or seven years time. Neil had studied mathematics before as part of a Higher National Certificate course and said he found most of the mathematics in *Open Mathematics* familiar. In my experience some students have found repetition of prior learning to be boring. In contrast, Neil was pleased to refresh his knowledge and skills. He found the course content very interesting and enjoyable 'because it related to the real world', volunteering comments such as:

> *Unit 5 'Seabirds' was superb. It's my hobby, bird spotting. ... and the 'Maps', we do a lot of walking as well. So very good. The 'Earnings ' um... it wasn't difficult, I just didn't find it to be interesting. But 'Prediction' and*

'Movement' were very good, 'Symbols', 'Graphs', and 'Maps', 'Health' were very good.

In terms of Taylor's categories of students' learning orientations (Beaty *et al.* 1997) Neil's orientation could be described as Vocational with Intrinsic interest given that he was doing the course because it was relevant to his work (rather than Extrinsic as he was not particularly concerned about gaining a further qualification).

First interview

In the first interview Neil gave details of his careful planning and talked about learning.

Planning

Neil said at the start of the course he used the planning sheets provided, but due to 'lack of time' soon found it hard to keep them up to date. He did not make a written timetable but, as he worked through the preparatory materials, he estimated how much time he might need for the main course. As a result he decided to find about twelve study hours a week. His wife went out to evening classes twice a week so he chose to use this time for his own study at home and settled into a pattern of about four hours on each of these two evenings, with extra time on Sundays when it was needed.

Neil was aware that he would have to find time for study from somewhere although he acknowledged that his personal circumstances helped him to find this easily. Neil established a regular study pattern early on in the course so he may have decided there was no need to spend time creating a written timetable. He already had one that worked. Perhaps his previous experience of study had prepared him for this. However, giving lack of time as an explanation for *not* doing the planning activities may indicate that he felt he *should* have been doing them. At this early stage of the course he may not have had enough confidence to judge which activities would be the most helpful to him.

Neil said he appreciated having externally fixed cut-off dates in *Open Mathematics*. For his Open College courses he could send for materials at any time of the year when it suited him and there were no set deadlines for assignments. However Neil found that this freedom did not suit him. He much preferred the fixed deadlines and structure of the Open University system even if, in an emergency, it meant doing assignments in the middle of the night. Like most students he encountered unforeseen events (in Neil's case this included the death of a close family member), but he said that when these occurred he always caught up and kept to the cut-off dates, sometimes taking leave from work to provide the necessary extra time.

In this first interview Neil was keen to stress that studying required discipline, especially the discipline of finding time. He wanted to find out whether he would be able to take control of his studying and pace himself rather than depend on others telling him what to do. When asked in a later interview whether there was anything from the learning activities in *Open Mathematics* that he would use on a future course he replied:

> *Yes, got to be the discipline of actually allocating time.*

I understood from the interview that Neil meant 'finding' and 'using' time rather than deciding what to study during a particular session. Although Neil may not have used the planning activities and the sheets provided in the course materials it seemed he was able to make time for studying and manage it effectively. He also made the most of the opportunities given to him and solved organisational problems as they arose.

Neil had studied for most of his previous courses (including his Higher National Certificate) what he called 'the easy way' by going to college in the evenings or on 'day release'.

> *You have to go there every week. Knowing you have to go there, basically, makes you go there even if you don't want to go. It's different when you have to pace yourself in your own time, be at home and actually turn that off* (the TV) *and then work.*

In a face-to-face college class situation there are externally set structures; the lecturer usually controls the pace and the content and the time and place are fixed. In saying that 'you have to go there' Neil could be implying that there is some kind of commitment; to the lecturer or to other students or that going to the college was the only way of getting access to the course material. Neil was aware that in the distance-learning situation it was up to him to control and make choices about when and where to study. Neil liked structures and boundaries but these did not always have to be set by others; he knew he could make his own. Neil managed his study efficiently.

Learning

When Neil was asked to describe the kind of learning he had done before *Open Mathematics* he said:

> *Always technical, always concise, to the point ...never used to do a paragraph where a sentence would do...*

This was unexpected and at first could be taken as a response to a misheard question about writing rather than learning but Neil explained that before *Open Mathematics* he had stuck to *facts,* both at work when doing reports and while studying previous courses. He said that he did a minimum amount of writing while answering the mathematics in the units and wrote answers in the margins of the text with working out where necessary. He then checked his answers with the given solutions at the back of the units. However Neil observed that he was now being asked to consider non-factual ideas such as learning and his feelings about mathematics. This was new to him and he found it difficult. Not only was he being asked to think about these more abstract topics, he was then expected to *write* about them. At several points in the series of interviews Neil explained that his 'pet hate' was written work. He found it difficult so tried to avoid it. Neil's comments about writing when he had been asked about learning may have been because he associated 'learning' as used by me with the learning activities in the units, most of which asked for written responses.

The remarks about writing were quickly followed by:

> *...you know part of this course is to do with learning isn't it, preparing for the next 5 or 6 years?*
>
> *It's made me do a lot more work. But I still find it a burden to do it. But the actual course itself, shall we say, the mathematics of the course ... without being burdened by the process of learning.*

So Neil was aware that many of the activities in *Open Mathematics* were aimed at improving learning. He then explained that it 'wasn't that the activities weren't good' but they would take up valuable time. In saying this he sounded somewhat apologetic but seemed to take some comfort in the fact that several other students in his tutorial group apparently felt the same way.

It may be that Neil regarded the mathematical content as being separate from the material designed to help the learning process, though the *Open Mathematics* Course Guide (Open University 1997) makes it clear that both mathematics and learning about mathematics are important aspects of the course. For example:

> *Open Mathematics aims to open up not only the power of mathematics but also the power of learning mathematics. Our aim is to help you to think about and improve your own learning skills and strategies so that you will be able not only to study this course successfully but also to learn effectively in the future.*
>
> Open Mathematics
> *Course Guide (Open University1997 p.10)*

Shiu (1996), the course chair of the Open University Mathematics Entry Suite, of which *Open Mathematics* is the first course, said that the Learning File must be presented as an essential, integrated and legitimate part of the course. However she pointed out that although *authors* may believe that learning activities are integrated into their courses the students may not share that perspective.

Although Neil recognised that there were elements about learning in the course, he may have been one of those students who saw the mathematics and the learning as being separate. The mathematics could be studied without the learning about learning. Alternatively it may be that having earlier taken scientific courses Neil found the mathematics of this course quite easy so was able to complete the mathematical activities with confidence. Perhaps he did not feel he needed to 'learn how to learn' as he could rely on previously successful methods. Possibly, the ways of learning suggested in the activities were different from the methods he was familiar with and he saw no need to adopt them. Perhaps Neil had not yet had the experience of 'getting stuck' which might require new strategies for learning.

When asked to give an example of a difficult part of the course, Neil said *Music* (Unit 9) was the only one so far. He had coped by using the advice in the Stop Press bulletins to be selective and concentrate on the topics needed later in the course. Neil followed this advice but he said it still took him a long time to work through the material and at the end of the unit he *'still didn't get it'.*

Unlike many of the other topics, the real-life context of this unit, *Music*, was new to Neil. Many technical musical terms were used and some of my own students reported problems with this. Even so, Neil was prepared to spend time on it, though it seemed to give him little satisfaction. Although he said he 'didn't get it', implying lack of understanding, he also said that he had 'cracked' the mathematics (for example frequencies) covered in the units. There was no indication that Neil used the learning activities in the course to help him improve and master the learning he found more difficult.

Neil said he chose to focus on those learning activities he found easy, for example the ones that involved the graphics calculator. However for activities where writing in sentences was required (rather than calculations) he said he restricted himself to scribbling short answers in the margins of the units or, he said,

I answer to myself verbally, I know I shouldn't, but I answer verbally, then check them after.

In the interview it was clear that 'verbally' meant orally, saying responses 'out loud' and then checking with the given suggestions in the unit. This may give a clue as to Neil's preferred way of learning. One of his main problems with distance-learning compared to conventional learning at college was the smaller amount of 'direct', face-to-face contact with a lecturer. In previous courses he had relied on listening to lecturers at least once a week and he had had more frequent opportunities for peer discussions with other students.

Working with others

The *Open Mathematics* course included face-to-face tutorials, at intervals of roughly a month. Neil attended these and explained that, rather than spend time by himself on difficult areas of the course or consult a book from the library, he preferred to talk with other students at tutorials as he found discussion helpful:

...you know the evening classes, there's not just the fact that you listen to other people, the fact that you talk to yourself and then you actually understand what it's about. ... Even though you are not sure, discussing it often clarifies your own mind. I don't get the answer off anybody else, actually discussing it helps, so that's the main thing.

There are at least two aspects here. Speaking in tutorials helped Neil to understand better and he also found that when studying by himself at home, talking or muttering to himself helped him to 'work out what it was all about'. This supports the conjecture that Neil's preferred method of taking in information was auditory rather than visual (textual) so discussion was an appropriate way of learning for him. His previous conventional courses with a lecturer at college may have suited him better than the large amounts of written material supplied with *Open Mathematics*. Although the course also encourages learning through other media such as audio- and video-tapes the responses to these activities are still expected to be in written form.

The second aspect is the opportunity for discussion and student participation in tutorials which Neil claimed helped him to learn and understand better. Unlike the weekly classes he attended at the Further Education college there could have been long gaps between the monthly tutorials with no direct contact with his tutor or other students. However, knowing that discussion with others helped him, Neil developed a good working relationship with another student on the course, Usha, (also a participant in this study), with whom he had regular telephone discussions which often lasted half an hour.

> *We talk quite a bit. In fact it was getting to the stage when we should have put each other on the Friends and what's it Family* ... [a discounted BT tariff]

At the start of these sessions, he said that each of them knew bits of the solution to a question but by the end they both felt that they had contributed and helped each other.

Collaborative working was something Neil recognised as being of benefit to him and he used all the opportunities available. Discussion with other students enabled him to mull over what he had learned and make his ideas into a coherent account.

Learning methods

Neil was asked whether he thought his method of learning might be different from that of other students.

Neil appeared not to have thought about his own methods of learning before. He implied that he had done a lot of studying as an adult and that 'you learn a lot by remembering and things like that'. In clarifying this he declared that he was 'getting old for the memory' so had to resort to writing notes on the corners of the units.

Neil said he did not actively engage in the end-of-unit activities which were designed to help students review their learning of that unit. He was asked whether he used the summaries and list of outcomes provided at the end of each section and each unit.

> *I just read through them, that's all. They show me what I should have learned through the course.*

Neil implied that he used the list of outcomes as a checklist though he may not have made comments or ticks and crosses as some students do. At this point, he did not appear to actively assess whether he was ready to move on to the next unit, nor did he go back and review work. However he said he would go back to previous units if, at a later stage, he came across something that he didn't understand:

> *You think you've got something, you think you've got something clear in your mind. Then the next chapter goes on previous knowledge and you think 'No', so you go back to the previous chapter and re-read it and then understand it a bit better.*

Neil recognised the occasions when his mastery of previous work was not enough for him to integrate new ideas so he took time to go back. Given his antipathy to writing as a tool for learning, re-reading may have been the best available method for him to improve or upgrade learning. From what he had said up to this point it was difficult to know exactly what processes were involved when he 're-read' the text so I planned to return to this aspect in the next interview.

Second interview

In this second interview, soon after he had completed *Open Mathematics*, Neil was asked whether he had noticed any changes in his learning since the previous interview about half way through the course. He confirmed that he still found discussion with other students important for his way of learning as 'discussing it often clarifies your own mind'. He

reminded me that he had found most of the mathematical content of the last few units relatively easy because he had studied most of it before, but that he had not spent time completing the Learning File sheets.

I asked Neil to tell me more about what happened when he found something hard and he needed to go back to previous units, something he had described previously as 're-reading':

> *A sort of revision I suppose. Difficult to describe ...the second part expands on the first part. The second book, you know the second volume and you thought you'd understood the first volume but you obviously don't quite get it because when it expanded on it something was still missing so you went back to the first one. It's just like re-visiting it or revision.*

It may be that Neil, in using 're-visiting' and 'revision' was implying something deeper than reread. Perhaps he was referring to revising his ideas or improving his understanding of a concept. The transcript does not show the diffident manner in which Neil gave his answer to my question. It was just one example of many in this study where a student struggled to find the right words to explain learning.

Again Neil explained that the hardest part of the course had been the written assignments. He wasn't expecting to have to write in a mathematics course, especially not 'in quantity'.

> *You know, for Sociology you expect to write reams. Everybody thought 'maths', numbers, and that's it but obviously a lot of it was analysing the work as well. You know, saying why the answer was wrong or why it's right.*

In the previous interview Neil had referred to his dislike of writing and said he avoided it as much as possible but now he reported positively:

> *...it [writing] was good in a way. I'm pleased though because it made me write a lot more. ...the course has made me do it'.*

He explained that whilst preparing his End of Course Assignment (ECA) for *Open Mathematics* he chose to write several versions in draft with many edits before submitting the final one.

> *That's one of the reasons I want a PC because I wrote things out several times and went over it quite a few times not just once. I wrote it out, reviewed it, see if I'd answered the question ... checked that I understood the question properly ... that's because I often jump to the wrong conclusion...*

Throughout *Open Mathematics* Neil wrote his assignments by hand and as he hadn't yet acquired a personal computer, all his ECA drafts also had to be written by hand. So, even though writing was his 'pet hate', he still did it and it seemed that the practice and experience helped him improve this aspect. He seemed very pleased with his achievements.

Finally, in this interview, Neil said that his main reason for doing this Open University course was to find out if he had enough discipline to make time for it and to work independently. He said he was successful in both aspects so would now choose to do Open University courses in future rather than conventional college courses. However he said that many of his work colleagues preferred the latter as they viewed it as an easier way of studying than distance-learning.

Third interview

As for all the students, in the third and final interviews I put each set of statements (printed on separate slips of paper see Appendices B, C & D) in turn, randomly on a table, so that we could both see them easily. With each set Neil carefully rearranged the slips so they were lined up one beneath each other before starting his comments. From the first set he

picked out 'I apply the mathematics from MU120 at work now' as the one he agreed with most:

> *Because I've learnt how to use the calculator properly now ... now I can do little programs which I've learnt through MU120.*

This developed into a discussion of how other people at work viewed his Open University mathematics studies. Neil said he had shown a colleague his *Using Mathematics* material. This interested the colleague so much that he decided to join Neil in doing the second level course *Engineering mechanics, solids* the following year.

Earlier we saw that Neil liked to discuss his *Open Mathematics* work with other students and sometimes his tutor. He also talked with his work colleagues and may even have influenced them in deciding to do Open University courses themselves.

Neil disagreed with the statement in the second set

I've never, as yet, phoned my tutor with a problem

saying that he had phoned his tutors on both courses several times. He found them to be very helpful, not by giving him the answers to questions but by 'pointing him in the right direction'. He agreed with

Explaining it to someone else is quite good

and he reminded me of the long telephone discussions with Usha, his fellow student for both courses.

As before Neil identified his main problem with 'home learning' was not being in a face-to-face class each week though he was keen to show how he coped with this by taking opportunities to consult others.

When it came to the third set of statements, R, (Appendix D) Neil studied them for almost a minute before he said:

> *What do you mean by um reflection, revision notes, reflection um... ?*

Rather than give him my own definitions I reminded him that these statements had been made by other students in the study and although different people might have different ideas of what the words meant, perhaps he could he pick out any statements he could relate to. He first picked out

I make revision notes

saying 'that's very true' and then he picked out the statement he himself had made in the previous interview:

For the End of Course Assessment I wrote it out and reviewed it to see if I had answered the question

Neil said that it was important for him to review his work because sometimes he did not answer the question properly.

> *... it was understanding, making sure I was giving an answer what they wanted... quite often the answer I put down was right but it wasn't what they were asking.*

Neil was very conscious that his answers didn't always match what the assessors were asking or expecting. In terms of the deference-confidence spectrum (Lockwood 1995) this might indicate that Neil was nearer the deference end. He was aware that the assessors would be working to given criteria with a mark scheme, so he needed to know what was 'wanted' if he was to be awarded the marks.

Neil also described the reviewing he had recently done while preparing for the *Using Mathematics* end of course examination. He had allocated two days for each 'book' (unit) doing what he called a 'general appraisal and overview and review'.

Neil agreed with the statement

I don't do things like reflect on progress

and said:

> *I didn't really think about um ... it's difficult to know what they mean by that, with respect to my progress. I just kept up-to-date on the course.*

Neil seemed to be relieved when I then moved on to another question. I asked him whether anything had changed during the year that he was studying *Using Mathematics*. He quickly said that he 'definitely learned more about his calculator' and he felt much more competent at maths as his maths skills such as equation handling and using matrices had improved.

Neil was prepared to use and describe his meaning of the words 'revision' and 'review' mostly in relation to his preparation for the End of Course Assessment or examination. Reviewing here seemed to be a form of checking. Neil was clearly not comfortable with the words 'reflection' and 'reflect'. 'Reflecting on progress' for him was about keeping to his timetable and time management rather than considering the state and progress of his learning.

Although Neil did not use the word 'reflection' some of the learning processes he was using can be matched to the three aspects of reflection as given in the final unit of Open Mathematics (Open University 1996c page 27). Neil had clearly *thought* about the work he had done in terms of the mathematics and his use of the graphics calculator. He showed that he could *identify* what he had learned and also when he had not learned it well enough. It is more difficult to comment on how he applied skills to new situations, especially skills in

learning. Possibly creating calculator programs for his work showed he that he could generalise his experiences for use in that area.

Postscript

After doing *Open Mathematics* (MU120) followed by *Using Mathematics* (MST121) Neil wanted to study what he called 'electrics' so at a course choice meeting he looked for a suitable course. He was disappointed to find that the only second level course in this subject was written in a style of what he called conventional textbooks and it appeared to be difficult to understand. It was presented in a very different way from the Open University courses he had taken so far. He was rather discouraged by this and said that as 'things change a lot in science', an 'old' course might not be a good idea, so instead he decided to register for T235: *Engineering mechanics, solids.*

Of all the students in this study Neil gave the most detailed reasons for his choice of courses. His critical examination of the course materials show that he was taking style and approach into consideration as well as content. Without seeing the relevant materials it was not possible to know whether there were other aspects beside the age of the course and its appearance that helped him reject this particular one. Up to this point Neil had just taken the two level one courses from the Mathematics Entry Suite. Although he said he had not done the learning activities in these courses, he may have been influenced by the structure and the design of these courses which were created to enable students to learn more effectively.

The firm Neil worked for sponsored many of its employees on courses. Some of them were given a 'day off' each week to study for a part-time degree at a nearby university. Even though as an Open University student he wasn't entitled to use work time for studying, Neil said that he was happy to stick with the Open University route. Together with his fellow workers he regarded the Open University method as being more difficult than 'day release', as it meant studying in your 'own' time and finding enough self-

discipline to work at home with its many distractions. This Neil was happy to do, though as he said:

When the sun is out it's hard. It's all right when it rains.

My resonances with Neil

Neil's experiences as a student in both distance-learning and face-to-face learning situations have enabled me to explore some of these issues and relate them to my own experiences.

My first undergraduate course was at a conventional university. I attended lectures where there was little contact between lecturer and student and there were no tutorials until the final year. However three afternoons were taken up with practical work in the Chemistry and Physics laboratories and it was here that there was a real community feeling, amongst students and our post-graduate supervisors so most of the time I was working with others. Like Neil, I did not, and still do not, like to work completely on my own. I believe I am at my best when I am able to work collaboratively. At the time I was changing to teach mathematics rather than science I took several Open University courses and attended tutorials. Wherever possible I joined a small local self-help group and for two of my undergraduate courses I went to summer school. For *EM235 Developing Mathematical Thinking* I had frequent discussions about aspects of the course with a teaching colleague who subsequently did the same course herself. For the dissertation for E802 *Applied Studies in Mathematics Education,* I was again able to work with colleagues even though they weren't doing the course.

Most of these courses were 'taught', structured ones with dates for assignments and examinations so there were externally imposed restrictions. This research study, for a

Master of Philosophy degree, has proved to be very different, with much less structure and a greater feeling of working in isolation. I was grateful at the start of this study for the Research Days organised by the Centre for Mathematics Education. These gave me opportunities for peer discussion in small groups in a 'safe' supportive environment where mistakes could be made, conjectures tested out and new vocabulary and meanings explored.

Relating Neil's story to the original research questions

Each of the original questions is discussed in turn.

1. To what extent was Neil aware of his own learning?

Neil was organised in his study arrangements and planned his time efficiently. He kept up-to-date with the course even when unexpected events occurred. In choosing to start with Level 1 courses he was realistic, even rather cautious, considering his previous experience in studying mathematics. Perhaps he wanted to feel on 'safe ground'. Neil was aware that his dislike of writing inhibited his written responses in all parts of the course, activities in the units and assessment. Neil knew that work with others helped with his learning so he made use of opportunities for this at tutorials and in phone discussions with both fellow students and his tutors.

2. Was Neil aware of any changes in his learning during the course?

In terms of approaches to learning Neil didn't seem to see any need for changes. He observed that his mathematical skills and calculator skills had improved. He was pleased with his increased confidence with writing which he attributed to having to do it as part of the course assessment. He achieved one of his main aims, that of having enough discipline to follow a distance-learning course.

3. How did Neil use the activities designed to help him how to learn?

Neil recognised that some of the activities were designed to help him how to learn but didn't see these as an integral part of the course. He said he read some of them and at times answered them orally to himself and occasionally with written notes on the pages of the course books. He didn't regard the learning activities as being important for him though he hinted that he *should* be doing them.

4. Did Neil use reflective type learning?

Neil did not introduce the word reflection and at one point, after I had introduced it, he asked what it meant. For the set of R statements (Appendix D) I had deliberately chosen several quotes that included 'reflecting', made previously by the students, to encourage comments on this topic. Of the seven 'reflecting' statements, Neil only chose one with which to agree or disagree strongly. It was almost as if he deliberately ignored them, perhaps because it was not a word he would use.

What I learned from Neil

Neil's story showed me that a student who had already studied mathematics at quite a high level could enjoy *Open Mathematics* and *Using Mathematics* and found the contents of the course useful for his work as an engineer. His approach to studying was straightforward, practical and realistic. Even though he may not have used the learning activities he got a lot out of the course. He proved to himself that he could study independently while also using opportunities to work with others. He recognised that having to do writing (which he hated) as part of the course had been beneficial in that he now found it easier. Neil used the calculator skills he learned on the course to write programs for his work. When he switched to studying with the Open University he soon rose to the new challenges and by

sharing his positive and enjoyable experiences with others became something of an ambassador for the Open University.

CHAPTER 7 USHA'S STORY

It is so much writing. I thought it would be just lots and lots of numbers, lots and lots of problems to solve.

This chapter describes the experiences of a student whose first language was not English and who had last done what she called 'proper studying' at school. She encountered problems with some of the writing in the course so this chapter includes an exploration of some of the different kinds of writing and levels of literacy needed for *Open Mathematics*. It also charts some of the changes in Usha's learning.

Background

Usha gave reasons for her choice of course and described her language and ethnic background.

Reason for choice of course

Usha chose to study *Open Mathematics* for her first undergraduate course. She found she had 'time on her hands' after her husband died and her son left home so she decided to study with the Open University. She worked full time in the product-testing department of a manufacturing company where she analysed test data and evaluated the effectiveness of equipment. Her employers paid the fees but left the choice of course to Usha:

> *Although there was not a burning reason for me to learn maths I wanted to learn it and that's why I enjoyed it.*

Usha's learning orientation fitted most closely into the personal category (Taylor 1983, Beaty, Gibbs and Morgan 1997) mainly with intrinsic interest as she was interested in self-improvement but she also wanted interesting relevant material.

Language and ethnic background

Usha is of Asian origin so, unlike the other students in this study, English was not her first language. Her primary school education took place in Africa where she said her teachers were often unqualified and 'English was taught by people who didn't know English'. Later she went to India to study and the examinations she took there (equivalent to 'O' level) were written in English. She has lived in the UK for some time and speaks English fluently and clearly. There were times during the interviews when the grammar of her spoken English was a little unusual and this may be seen in some of the quotes used in this chapter, but she appeared to understand my questions easily and responded to them readily.

Woodrow (1996) looked at the choice of Higher Education courses made by different ethnic groups in the UK and found that Asian and Chinese students chose mathematics and science in greater proportions than their white peers. Possible reasons for these factors included implicit curriculum bias, social assumptions, learning styles, personality preferences and career intentions. *Open Mathematics* would seem an appropriate choice for Usha as she enjoyed mathematics and was already working in a scientific environment.

First interview

Usha discussed her learning, ideas about planning and various issues about the quantity and types of writing required for the course.

Learning and applying

Early in the first interview Usha was asked whether anything had changed in her learning since the start of the course.

> *I was quite disciplined about learning before the course so that hasn't changed much.*

But it's the way I take in information. I think that has changed quite a lot.

Usha's previous study as an adult had been on courses such as cooking and reflexology at evening class so being 'disciplined' may have been referring to the commitment she showed in going to classes to learn new skills. She was using 'learning' in the sense of study skills and patterns, whereas 'the way I take in information' referred to a change in the process of her learning, and may even have indicated an awareness of some aspects of a deep approach to learning (Entwistle 1997).

Usha gave another example of a change in her learning by saying she now applied 'it' (mathematics) at work. As an example of this she explained how, before the course, she used the technique of standard deviation at work. She just punched buttons on the computer, the answer appeared but she had no idea what was happening. Now she could understand better the underlying statistical principle.

Usha made direct connections between the mathematics she was learning in *Open Mathematics* and the techniques she used at work. She was pleased to find out the theory of standard deviation, something she frequently applied with a program on her work computer. Statistics is covered in the first block of *Open Mathematics* so Usha was able to relate her learning from the course materials to her work very early in the course.

Planning activities

Usha said the pro-forma planning sheets provided in the course materials were 'a waste of time' so she did not use them. She had plenty of time for studying and her course materials were permanently out on the dining table, ready to be picked up when she had time to spare

I find I'm using up more time planning this than actually doing my work ...wasting time.

I don't actually write down what I'm going to do ...whenever I have the time I just sit at the table, all my books are open all the time.

Usha lived on her own and appeared to have plenty of time for study so she may not have seen the point of making a written timetable. The prescriptive pro-forma sheets provided for these planning activities may also have been off-putting. However, by *not* creating a timetable Usha may have missed out on the possible benefits. Other students in my experience, including one in my pilot study, have found it helpful to use them as working documents. By monitoring the time taken for each unit they have been able to plan more efficiently for future units when the work tends to become more difficult and time consuming.

Tackling assignments

Usha said she changed the order in which she approached the assignment questions. For the first Tutor Marked Assignment (TMA), she completed the material in the relevant units first and then did all TMA questions together. However she found this method to be 'murder' so while things were 'still fresh' in her mind she did the associated TMA question straight after each unit.

There was no suggestion at this stage that Usha missed out any work that was not specifically needed for the TMA; it was a matter of choosing an order that was most effective for her. She found that smaller chunks of work were easier for her to take in. She waited until the end of each unit before looking at the relevant questions so she could be described as a 'TMA Aware 'student rather than a 'TMA Dominant' one (Lockwood 1995).

Handbook activities - explaining mathematical terms.

Usha said that she started off with good intentions when asked to write responses to the learning activities in the units:

When I start a unit, I'm very good about it. When I start I write everything I need to write, loads of things but at the end I think I forget about it and I'm

> *so engrossed in my units and I forget the writing about my learning. Sometimes I do but sometimes I think it's important I do write it down.*

Usha displayed a tension here between writing about her learning and doing the mathematics. She knew she was expected to write about learning but felt guilty that she did not do it. She got involved in doing the mathematics, the calculations, and by becoming engrossed, 'forgot', intentionally or unintentionally, about the learning activities. If she had been fully engaged with the material, as the course writers had intended, then the writing activities should have been an integral part of her learning. She may have avoided the activities because she was not confident enough to analyse her learning or she lacked suitable words to describe it.

'Sometimes I think it's important to write it down' could be taken in more than one way and at the time I did not check on Usha's meaning. She may have felt it 'important' in the sense of the course expectations, an external authority, or she may have meant that she *herself* thought it was important. If the latter, this might indicate that she was acting as an independent learner and making choices, though not always confidently.

Although Usha didn't do all the learning activities she said she always used the blue coloured handbook sheets which were provided for students to write down definitions and explanations of mathematical terms.

> *The reason I do them* [the blue handbook sheets] *is because once I write something I feel I can memorise it a bit more. Once I have written something then I can recollect it much faster.*

Here Usha was clearly making her own decisions about what which type of learning activity would be the most useful and effective for her. She was aware that the activity of writing enabled her to memorise and then 'recollect' things and implied that this was more effective than just reading. Usha found the writing for the handbook activities to be useful and certainly not a problem, unlike the writing for some of the other activities.

The *Open Mathematics* course materials suggest that writing explanations in ones own words is a good way of learning for understanding so I asked Usha whether she used her own words when she wrote definitions and explanations.

> *Sometimes I do, but quite a lot of times I take it from the units because especially some of the expressions I don't feel that I can change it in any way.*

There could be several reasons why Usha didn't feel she could change the 'expressions'. In the sense of 'change' meaning 'improve' she may have thought her command of the English language wasn't good enough. She might have felt that as experts had written the explanations printed in the materials, how could she, as a mere student, better them? It might be that, having seen a definition expressed in a particular way, this acted as a 'block' preventing her from finding alternative words. Scientific and mathematical definitions are often very concise and specific, leaving little room for reformulation. Alternatively Usha might not have understood the concept well enough to use her own words.

Usha said that explaining something to someone else was a good way of 'learning'.

> *I think explaining it is quite good as well because I do use my son sometimes. He would listen and I asked him if that was the right way I put it and he said 'Yes' and what he heard he knew what I was talking about.*
>
> *I feel I can grasp the mathematics more quicker than if I was writing ...*

Here Usha had moved beyond memorising and recall to the notion of grasping a concept, making sense of it and trying to make it her own. She felt that she could clarify an idea for herself by explaining it to her son orally, probably using her own words, rather than merely repeating the words from the text. Having her son as audience, not only to listen to her, but also to give sympathetic feedback was a great help to Usha. Oral explanations were like stepping-stones to written ones though it is not known whether, having successfully explained something to him, Usha then felt more able to put this in writing.

At about this time I also interviewed Neil, the subject of the previous story. He told me that having regular weekly phone discussions about the course with Usha was a great help to both of them. Only in the third interview with Usha, some sixteen months later, did she herself tell me about these discussions and how useful they had been.

Distance-learning can be a solitary experience and though Usha never complained about this directly, she was pleased to have someone, including me as interviewer, with whom to discuss her work and enter into dialogue.

Written answers

Usha made many references to writing in all three interviews. Usually she said she hated it although at times she also said that she recognised its importance. One of her reasons for choosing a mathematics course was to 'avoid written work' so she said she felt 'let down' when she found how much writing was expected in *Open Mathematics*. However, even at this half-way stage of the course Usha said that writing had become easier, though not easy, because she had had to do so much of it. She said she could now write more quickly and naturally than before the course began. For example:

> *Before one question* [for a TMA] *took me two days, I think, but the last one I did before going to work in the morning.*

Usha then commented about the wording of some of the TMA questions and said she sometimes had difficulty in interpreting their meanings.

> *What are they asking for? Once you know what they are asking for it's usually easy to answer the question.*

She then spent some time giving an example of such a difficulty that she had found with a recent TMA question:

> *... they said draw it in four graphs and I said 'Do they really want more graphs because I drew it in one graph, you know, it was train journey, like starting and then at cruising speed and then slowing down and I drew it on one graph and I thought that was all right in sections and then in graphs and I thought do I really need to separate this out because I didn't even know ... ...it's like one word can make a difference.*

Usha was obviously confused. Much later, after the final interview when it was too late to explore this issue further, I examined this particular question carefully to see where her difficulty might have been. A timetable for a rail journey was given with the starting and end stations and four station stops in between and also the number of miles travelled on each stage. Using these data, a poorly drawn distance-time graph was presented to the students and they were asked first to say what was wrong with it and then to draw it properly. I could see no suggestion in the question that the student should draw four graphs and it was difficult to work out how she came to this misunderstanding. It is possible that the large number of words in the question put her off reading it carefully or she may not have been familiar with all the terms used. It may been have been that her command of English wasn't quite good enough for her to understand the nuances of the question.

Although Usha's experience that 'one word can make a difference' is probably true for many students, even those whose first language is English, I have observed that it can be more difficult for students where it is not. One of my own students, whose first two languages were Arabic and French, misunderstood a couple of words in a TMA (2001 TMA05 number 5):

> *Look back over the course so far and find examples of your own work involving gradient. Choose one example of your own work which in your opinion illustrates your understanding of the use of gradient.*

He interpreted the phrase 'own work' as being an activity that was personal to him, so he measured the gradient of the slope outside his house. What was expected was an example of

his own working of an activity from the course materials. In discussion with him later he explained that, for him, 'own work' implied something that did *not* appear in the course units.

'Essay' type questions and writing about learning

Usha found some types of writing more difficult than others:

> *It's not the writing, it's the thoughts, putting the thoughts ... like writing letters. It's so much writing! I thought it would be just lots and lots of numbers, lots and lots of problems to solve.*

In referring to thoughts and writing letters it would seem that Usha was thinking about affective writing in particular. Evans (2000) sees affect and emotion, as inseparable from thinking, including mathematical thinking but this may be a new idea for some students including Usha. She was not, as some students are, anxious about her mathematics but she was diffident about writing about her 'feelings'. She may not have fully understood that the purpose of these activities, especially those she called 'essays', was to encourage students to reflect on their learning experience and provide their tutors with information in order to help the learning process.

It is not easy for prospective *Open Mathematics* students to appreciate the quantity or range of writing they will be required to do. The course description (see Appendix A) refers to the aim of improving communication skills but does not explicitly mention the skill of writing. Yet in my experience some students, especially adults returning to learning after some time away, do not realise that communication includes writing. When Usha was considering her registration for the course, the only explicit reference to writing in *Open Mathematics* appeared in the Vocational Qualifications paragraph for those who were planning to follow the VQ route and it could easily have been missed by those who did not.

In recent years 'writing to learn mathematics' has been advocated by Countryman (1992), Waywood (1992) and others, who say that journal writing can develop confidence in students. It can also provide opportunities for monitoring progress and can increase

communication between teacher and student. In face-to-face teaching and learning situations it may be relatively easy to set up a dialogue between student and tutor using such journals but for distance-learning the reduced direct contact would seem to make it more difficult. Before *Open Mathematics,* few Open University courses included journal type activities. Thorpe (1995), reporting on one such course, *Approaches to Adult Learning*, found that a portfolio or journal kept by the student and *not* assessed by the tutor was a relatively weak strategy for stimulating critical reflection. Some of the Learning File activities in *Open Mathematics* cover some of the same intentions as a journal. However most of the responses to these would not be assessed or receive feedback, the exceptions being the 'reflection on learning' question in each TMA, what Usha called 'an essay'.

Communication plays a crucial role in many mathematics practices but not all students find mathematics writing easy so may not be able to convey their mathematical thinking or write about their learning of mathematics (Burton and Morgan 2000). Those advocating 'writing to learn mathematics' may assume that students already know how to write or will 'just pick it up through experience.' In Usha's case it could not be assumed that she already knew how to write in an appropriate style for *Open Mathematics* though she maintained that her writing skills improved through practice and experience. I return to the issue of academic literacy later in this story.

Second interview

Usha again complained about both the quantity and some of the types of writing she had to do for *Open Mathematics* though she reminded me that writing helped her remember the mathematics. I asked her what she meant by 'remember':

> *I can recollect it ...most of the time ... you feel 'Oh Yes, I wrote it down you know'. If I read sometimes, um I've read it and it's not registered.*

> *But when I write it it's definitely registered and I've understood it ... having understood it I can sort of put it in my own words*
>
> *Because I've understood it, I can put it in my own words, but otherwise if I haven't understood something I couldn't describe whatever I've learned again to anybody.*

This sequence of comments gave a clearer picture of the connections Usha made between writing, understanding and learning. In this interview she explicitly gave the order this happened; understanding something meant that she could put into her own words so writing was proving to be a useful way of not only remembering but also understanding. However, even though writing was getting easier, Usha was keen to tell me she still didn't *like* writing.

Usha said that for her, the process of understanding took a long time.

> *I must say it does take me a long time to do each unit, um, basically because I'm learning all over again ... it's a different way from what I learned at school you know. It's a totally different way of learning. I mean doing those ratios, triangles, tangents. I've never done anything like that before.*

Usha referred here to the content of mathematics rather than the process of learning. There were times in the interviews when she hinted that her slow speed was related to the different way the course was delivered compared to her previous mode of study.

> *I don't like not understanding something you know. I want to understand it before I go any further.*

In wanting to completely understand something before going further Usha suggested that for her learning occurs in steps, each to be mastered before moving on.

Usha also reported changes:

> *I still don't like writing, but having said that, the words come more easier than what they used to. I think because I'm in the mode of learning. ...now I'm geared to it ...I don't think about it but before I would put it off.*

Usha was aware that the experience of writing and being exposed to the learning elements of the course, were enabling her to become accustomed to a more academic type of writing. Perhaps, as Taylor *et al.* (1988) would say, she was becoming 'literate by degrees', a term they used to describe how students in higher education come to learn and understand an academic discipline by learning how to participate in the discourse of that discipline. For Usha, as for most students, there were several areas where she had to become more literate; in learning mathematics, in learning about learning and in assessment. Those students like Usha, whose first language is not English, may also have extra problems to overcome in understanding some of the intricacies of 'everyday' English.

Wood (2000), in an interim report for the Open University Interregional Skills Development Project, describes action research carried out by tutors on two level one courses: *Understanding Health and Social Welfare* K100 and *Open Mathematics* MU120. One issue that arose was academic literacy; students reported that they found it difficult to know what a particular course demanded. Wood's study suggests that tutors need to identify and address these needs explicitly especially in the early stages of the course and with students on their first Open University course. One particular request made by the *Open Mathematics* students in this study was advice on how to analyse a question, something that Usha also felt the need.

End of Course Assessment

I asked Usha whether preparing for the ECA had had any effect on her learning:

> *I did spend time on it but I don't think it was too different to doing a TMA really. It was very similar I thought, but I was worried. You know I thought it was easier than what I was worrying about.*

Usha commented on the practical aspect of time in relation to doing the ECA but not directly on her learning. I was surprised that she found it similar to doing a TMA, as most of my own students have found that they need to use a wider variety of processes for the ECA, such as

identifying and selecting pieces of their own work, in order to demonstrate their understanding of terms such as 'ratio' or 'phase shift'.

When I asked Usha to look at the diagram in Unit 16 *Mathematics Everywhere* (Fig. 3 in chapter 1), she said she hadn't looked at it before but then said:

> *I don't do things like reflecting on progress.*

I encouraged her to explain what she meant by this:

> *...On some of the subjects, what stage were you when you started and where you are now. But it's such an ambiguous thing, I think, you know when you say 'reflecting on progress'. Um ... are we just talking about the maths here? Or just the whole general term of learning because that way I feel I have progressed. I have learned all round – not just maths.*

I picked up on her last point and asked her what she had learned from the course besides maths:

> *I've learned a lot, how to learn, how to study, how to manage your time, how to apply it outside as well as here ...once you learn something you learn something, until ten years then it is forgotten, but if you don't use it, it is forgotten.*

Usha was aware that, in broad terms, she had learned a lot from the course both in terms of the mathematics and the study skills. Her comments about learning something, in the sense of retaining, for ten years seemed to be relating learning to memory though she also implies that knowledge is forgotten if not used. This notion may have come from her previous learning experiences.

I asked Usha whether there was anything in particular in the course that helped her progress in learning:

I think the TMAs ...I mean you study it then ...TMA helps you apply it doesn't it in the end?

Usha was aware that doing a TMA provided a focus for her learning of a particular topic. Gathering the right material together and writing the solutions may have helped her consolidate her learning. Knowing that she would be assessed and get feedback may have provided her with motivation.

Third interview

In this interview, when Usha had just completed *Using Mathematics,* she confirmed many of the statements made in the first two interviews and explicitly said she did what she called the mathematical exercises but not the learning activities:

I did very little learning file sheets. I could have made time if I'd wanted to but I just didn't have the inclination to do it.

Usha amplified this by saying that sometimes she read the activities and thought about them but she didn't write any of her responses on the *pro forma* sheets. At one point she said she didn't write them down because she was 'lazy'. She particularly objected to the TMA questions where she had to assess her skills and report on progress.

The type of written work I don't like is what I knew before, what I know now, find the difference, write all these things ...It kept on saying 'Write down how much you've progressed, what did you know before and what do I know now.' I didn't like that.

Usha offered various explanations for why she didn't like this writing. She said that self-assessment was a skill that didn't come 'naturally to her' and as an adult she said she didn't like being told what to do.

Using the word 'lazy' sounded as though Usha knew that this writing would involve effort. She had already indicated that she had enough time to do them but not the inclination. The written responses would be a solitary activity with the audience being Usha herself but we have already seen that she preferred to use a dialogue approach to learning. It may have been that Usha didn't have the words to describe her learning. She certainly did not seem to see the point of these learning activities especially as she had no particular academic goal in mind.

Reading

While examining the M set of statements (Appendix B ref. mL), Usha picked out

I learned how to learn

to agree with strongly so I asked her what had helped her to do this.

> *The way I read* [past tense] *the material ... not reading irrelevant things ...You know I could separate things out more than what I used to, which means hopefully my speed's gone up a bit. I mean in maths there's so much involved in how you read the stuff really.*

In the first two interviews Usha has reported that she could now write faster and better than at the start of the course and now she commented on the increased speed of her reading. Perhaps she was getting used to the language of *Open Mathematics*, especially the mathematical language.

Reflective learning

As Usha sorted the third set of statements, R (see Appendix D), she first picked out the statement she herself had made in the previous interview:

I don't do things like reflecting on progress.

followed by:

> *I don't know why, but I don't. I mean I feel that if I need to I'll apply it what I've learned but I don't actually reflect on what I've done. I don't know how to reflect on what I've done.*

Usha appeared to be saying that she did not reflect in the sense of looking back on what she had done and how she had learned something but she did recognise that she might apply what she had learned.

She then picked out a statement *(ref. rA* Appendix D*)* with which she disagreed,

> *I wouldn't say that*
>
> *Reflecting means looking back over your work.*

and volunteered her own ideas on reflecting:

> *I'd say that reflecting is just thinking in your mind ...just shutting your eyes and just thinking about it not actually looking at the books or something. That would be my idea of reflecting.*

Usha's definition of reflecting would seem to be the more everyday passive one rather than the more active process suggested in *Open Mathematics*, the type of reflection which can be used to make changes. This was an example of how useful these sorting exercise with the statements could be; by disagreeing strongly with one of them, Usha produced her own explanation of an issue.

Confidence and mathematics

Usha said that the two courses *Open Mathematics and Using Mathematics* had given her confidence in her mathematics so that she could use it at work. What is more, she said her boss had also noticed this increased confidence:

> *Well he thinks it's great, well I didn't get a promotion or anything for it* [laughs] *but it was like, it went on my performance management, end of assessment performance management.*

> *Yes, I mean before, I never looked at anything, anything with a view of going deeper into anything. If I had an experiment to do, right, I'd just do it. I'd get the data and then presented the raw data for somebody else to sort it out. But after doing the course, and of course doing a bit more computer work as well, I don't present the raw data, I analyse the data and then present it so that way I do look at things differently.*

Usha felt more confident in her mathematics and her ability to apply it at work. By reporting this to me she was making a self-assessment quite readily and with examples to back up her statement. It may be that she didn't realise that this was what she was doing, she didn't relate it to what she had been asked to do in the self-assessment activities, the ones she didn't like.

Usha also described the reaction of her work colleagues when they saw her using the graphics calculator:

> *Oh they think I'm very clever!* [laughs]. *But I don't feel I'm clever mainly because I've just – I've used it so much and um I think the books the Open University had with the graphic calculator they were very good. I've lent somebody else my books now and he keeps coming to me and saying 'How do you do this and how do you do that? and how do you get box plots?' You know.*

Usha gave credit for some of her new skills to the graphics calculator books provided in the course and she also shared these skills with others.

Postscript

After *Open Mathematics* Usha went on to do MST121, *Using Mathematics*. She said she was pleased to have taken both these courses but felt she had now reached her limit in studying mathematics. However she felt confident enough to study M206, *Computing: an object- oriented approach* the following year. After that she started T171 *You, your computer and the net,* but part way through, after a lot of deliberation, she decided that this

course was not for her. She said she gave up because she had had enough of studying and, as far as is known, she has not registered for further Open University courses.

There may be other reasons why Usha did not continue with her Open University studies. From the outset she was not aiming for a degree but to fill in some spare time. She enjoyed the mathematics courses and found some of the contents related to the mathematics she used at work. The computing courses were not so directly linked with her work, so this may have been a reason for her decision not to continue studying. I did not have the opportunity to explore further her reasons for not continuing with *You, your computer and the net* but some of my students have commented on the large amount of reading required for this course so this may have been a negative factor for Usha too. On the positive side, Usha was pleased with the increased confidence she had gained as a result of her Open University courses so at this stage she may have got what she needed from them.

My resonances with Usha

Usha's many references to writing struck a chord with me and set me thinking about why I still have problems with writing despite much practice and experience. By 'writing' I do not mean writing mathematics in particular (or indeed writing *about* mathematics) but the *process* of writing in general, what I think of as being the journey from 'ideas in my mind' to 'words on paper '. It takes several drafts, and a lot of time, for my written words to reach a state where they are both acceptable to me and can also be shared with others; an example would be writing up this study! I found it much easier to tell people orally about what I was doing than to put it into formal writing. It would seem that Usha also preferred communicating orally rather than in writing.

I was unhappy about the analysis of the interview data from Usha and the subsequent story I created. I rewrote it several times without success until I realised that my own concern about *writing* made me pursue only that aspect of Usha's learning; a case of my own

resonance obscuring the real issue. With more careful attention I might have realised earlier that Usha's problem could have been the wider one of having a limited understanding of the vocabulary of learning in both reading and writing.

Usha said she appreciated the opportunity to think about her studies and her learning during my visits and in discussion with me during the interviews she seemed happy to *talk*. Indeed her confidence seemed to grow as the interviews progressed and she seemed to me to be more perceptive and thoughtful about her own learning. Just as she had found it helpful to discuss the *mathematics* of the course with her son or with other students, it may be that similar discussions about learning could have helped Usha to clarify her thinking so that she would have felt more able to write about it.

Relating Usha's story to the original research questions

Each of the original research questions is addressed in turn.

1. To what extent was Usha aware of her own learning?

Usha knew that she worked slowly and did a bit at a time, as she found the work easier to understand that way and she was keen to understand it. She knew she could understand a concept once she could confidently put it in her own words, usually orally but also to some extent written definitions. She was aware that working with others was her preferred way of learning, so she used her son and also a fellow student for this. She liked to link aspects of the course with her work and was very pleased that she could apply some of it and even share this with colleagues at work. She didn't like written work such as self-assessment and reflecting on progress. She found doing the TMAs provided a focus for her learning.

2. Was Usha aware of any changes in her learning during the course?

Usha found that writing became easier though not easy. This was probably due to practice in the activity of writing but also because the course texts were helping her to become accustomed to the new vocabulary, both of learning and of mathematics. She was aware that working with small amounts of material at a time was best for her so she changed the way she tackled her assignments from doing questions on several topics at once to doing one question at the end of each relevant unit. She said another change had been the way she took in information, implying that this was at a deeper level.

3. How did Usha use the activities designed to help her learn how to learn?

Usha found the handbook activities very useful so she did them. The planning activities were seen by her to be a waste of time so she didn't do them. She said she 'did' some of the learning activities in the sense of reading them and thinking about them but she didn't write down her responses. The self-assessment and the reflecting on progress activities she did not like at all and therefore did not do them.

4. Did Usha use reflective type learning?

Usha said she did not do things like reflecting on progress, but she also said she didn't know how to do it, with the implication that she didn't know what was expected by the term 'reflecting' in the context of *Open Mathematics*. Her understanding of reflecting was one of looking back at work. However in terms of the processes described in Unit 16, Usha described occasions when she not only thought about her work, but she also identified what she had learned and applied some of her learning experiences to new situations, including her job. This suggests that Usha did use some of the processes of reflection to some extent but did not realise she was doing this.

What I learned from Usha

Usha's dislike of writing and her possible difficulties with fully understanding English may have been due to English not being her first language. Her comment in the first interview that she was taught 'English by people who didn't know English' may have been more significant than I appreciated at the time. In the interviews she herself made it clear that writing caused her problems but her apparently fluent spoken English may have misled me into thinking her understanding of English was better than it was.

Analysis of the interview transcripts, both what she said and how she said it, encouraged me to think about the level of literacy needed for *Open Mathematics*. I looked for guidance in the booklet *Effective use of English* (Johnson and Goodwin 1997), in the Open Teaching Toolkit series. In the section entitled 'Finding out about a student's language history', they suggest that tutors should ask their students, at the start of the course, to reflect on their language history, not just about their use of languages other than English, but about the types of language they have experienced in the workplace or in previous study. Students should then be asked to consider which language skills they need to develop.

In *Open Mathematics*, students are asked to describe their *mathematical* life histories and some do this willingly, others with more resistance. Specific reference to language history is not asked for but, given the quantity of reading and writing required for *Open Mathematics*, some kind of assessment of language needs could be useful for both student and tutor. Finally, in looking through my *Open Teaching Toolkit* box, I was reminded of all the other excellent booklets in this series which are issued to us as Open University Associate Lecturers but may not always be used enough.

CHAPTER 8 SUMMARY AND CONCLUSIONS

The data for the main part of this study came from just five *Open Mathematics* students, all from the same tutorial group, yet the interviews revealed a wide variety of views and experiences about studying and learning. With such a small group I had no intention of making generalisations or describing stereotypical students. Indeed, from my own experience, I would suggest that there is no 'typical' *Open Mathematics* student though there may be several general *types* of student. Many of these types are not represented here, for example, students who plan to go on to do a mathematics degree and those who were terrified of mathematics at school but finally pluck up courage to try again.

I was fortunate that, after the first interview in the middle of their study of *Open Mathematics*, all five students agreed to be interviewed twice more over a period of eighteen months; soon after the course had finished and finally one year later. In the stories the quotations and the 'accounts of' should be fairly reliable as they are taken directly from the interview transcripts. However I am aware that the relationship between me as interviewer and the student as interviewee may have affected the narrative and in places I have commented on this. The five students have not read the 'accounting for' sections so the interpretations are my own and not checked by them.

With a wealth of data from the fifteen interviews it has not been possible to explore all the issues that arose so I have had to choose what to include and what to explore. I am aware that other researchers might get different data from the same students or would use my data in a different way. The most important reason for my doing this study (in the role of researcher rather than tutor) has been to make me consider some of the issues of learning relating to students I work with as a tutor on the *Open Mathematics* and *Openings* courses.

General points about the student group

Anna was a continuing student who had previously done the Arts Foundation course, but the other four students in this study were studying *Open Mathematics* as their first Open University course. In the year of the first two interviews all five students were studying just this one course.

Reasons for studying and outcomes

Anna was aiming to be a primary school teacher so mathematics would be useful for that. Neil had work related reasons for studying mathematics first before doing specialist engineering courses. Both these students continued with the Open University. David's previous attempts at studying had not been very successful, but he wanted to 'learn how to learn'. As he felt fairly confident about his mathematics, he chose to start with *Open Mathematics*. Despite the handicaps of what he called his 'psychological blocks' and a pre-conception that learning was 'remembering' he appeared to overcome his many problems and, against his expectations, continued with further Open University courses. Helen and Usha had no particular academic or work-related reason for studying but wanted to fill in time. After *Open Mathematics* Helen discontinued her Open University studies and took vocational ones instead. Usha completed two more but then gave up half way through the third saying she had done enough studying.

Summaries of findings from the original research questions

In this section some of the findings from the study are summarised and comments made. More detailed answers to the four research questions are given in the individual stories.

1. To what extent are *Open Mathematics* students aware of their own learning?

As a continuing student Anna was already familiar with the Open University systems and had experienced study at university level. She was ready to adapt her way of studying when necessary and was aware that she was becoming a more independent student though she seemed to be more aware of the practical issues relating to her learning than of the processes of learning.

David, in the first interview, seemed to equate learning with memory but as the interviews progressed his awareness of all aspects of learning became more evident. Indeed he was very aware of his own learning and knew that he created blocks which needed to be overcome. Once he had overcome his reluctance to try new media such as audiotapes he accepted and then enjoyed working with it. He also knew that working with others was effective for him, but only when he liked the make-up of the group. David said he was a 'visual' learner and preferred to work with diagrams rather than text.

Helen considered her own learning mainly in terms of the satisfaction she got from organising her study materials. However she knew that her understanding of some of the work was not always robust and was aware that she needed to return to previously studied material. She was frustrated when she did not understand something or found it too difficult but did not appear to have strategies for coping with these situations.

Neil was aware that he was cautious so chose a course that he could cope with easily. He was aware that his dislike of writing inhibited his written responses in all parts of the course, both activities in the units and assessment, but he was also aware that the practice he gained when writing assignments helped to improve this skill. Neil knew that work with others helped with his learning so he made use of discussions with both fellow students and his tutors.

Usha knew that she worked slowly so she did a bit at a time, as she found the work easier to understand that way. She knew she could understand a concept once she could confidently put it in her own words, usually orally but also to some extent in writing. She was aware that working with others was an effective way of learning, so she used her son and also a fellow student for discussions. She liked to link aspects of the course with her paid work and was very pleased that she could apply some of it and even share this with colleagues at work. She didn't like written work such as self-assessment and reflecting on progress. She was aware that doing the TMAs provided a focus for her learning.

Comments

None of the students, apart from David, seemed to have thought about their learning before the interviews with me and in general they had not used the 'learning to learn' activities in *Open Mathematics*. At the time of the first interviews my own knowledge of adult students' conceptions of learning was not well-developed so I was surprised that when I asked questions about learning I received responses about what I would term study skills. For example, Anna described the summaries she had made for her 'revision notes', Helen was concerned about making time for study, David wanted to learn mnemonics for memorising facts and Usha had her difficulties with writing. I had hoped (somewhat naively!) for more awareness of learning in the sense of understanding and applying, so I needed to use several probes to elicit comments about learning styles. Further probes elicited some examples of deeper kinds of learning, most particularly from Usha with her descriptions of how she worked with definitions orally in order to understand the concepts better and her examples of how she applied techniques from *Open Mathematics* at work.

These differences between my conceptions of learning and those of the students may be noticeable in some of the stories. Sometimes the words 'studying' and 'learning' have

been used interchangeably which may have resulted in some confusing interpretations. Svensson (1997 p.71) concluded that skill in studying is not the same as skill in learning saying: *'Improvements in skill in learning are not specific to the content of that unit but are about understanding and learning how to learn.'* This kind of improvement is difficult to chart over a short period of time though might be expected over a longer one as was found in the longitudinal six year study of Morgan and Beaty (1997). They concluded that *'students moved from the idea of learning as memorising and additions of knowledge towards the idea of learning as understanding and as relating to life'*.

2. Are *Open Mathematics* students aware of any changes in their learning during the course?

Anna was aware that she was making choices about which activities would be useful to her and that she was becoming a more independent learner. As the course progressed and the content became more difficult she made more detailed notes more frequently. However she appeared to make few other changes and at the end of her third year of study with the Open University implied that her approach to learning was similar to that in her first year.

David seemed to be more aware of his own learning and changes in it than the other students in this study, despite not having done the learning activities and his reluctance to try anything new. This may be because there were more changes to report or perhaps that David was more willing to share his ideas and opinions with me. He was aware that his confidence had grown over his first two years of studying with the Open University and that he was more prepared to work in a group situation and to ask questions at tutorials. He changed his attitude to new media and even the graphics calculator. David was aware that he had overcome some of his fear of failure which had affected his previous studies. The delivery of mathematics through real-life contexts had been a successful way of bringing him back to study. It had helped him to look at things differently and even recognise that

he might change from his old way of learning of being told 'follow this, learn that'. David also learned that for successful study he needed to give more time to it and give up some other activities.

Helen was aware that as the material became more difficult she needed more time for study and as she was short of time she 'skipped' things she did not feel to be necessary, in particular the learning activities. Rather than being aware of any changes in her learning, Helen said that she used the same study methods that had proved effective in previous courses, for example making notes for recall and revision purposes. In general she seemed to have resisted the suggestions made in the course materials to try activities designed to change, develop or improve her learning.

Neil didn't seem to see any need for changes in his approach to learning though he observed that his mathematical skills and calculator skills had improved and was pleased with his increased confidence with writing.

Usha found that writing became easier though not easy. She was aware that working with small amounts of material at a time was best for her. She changed the way she tackled her assignments from doing questions on several topics at once to one question at the end of each relevant unit. She said another change in her learning had been the way she took in information implying that this was at a deeper level from previously as she could now use and apply this information.

Comments

Although the students had access to their Learning Files during the interviews they had few entries to refer to. Giving examples of any changes in their learning did not come easily for Anna, Helen and Neil. However Usha reported several changes and seemed to appreciate

the opportunity to reflect on these. David gave examples of many changes and improvements.

3. How do Open Mathematics students use the activities designed to help them how to learn?

Here the students' use of the different types of learning activities are described and then discussed in turn.

Planning activities

Anna, the only one who had done an Open University course before, found the planning activities and associated sheets to be useful. David said that at the start of the course he did not see the point of planning but as the work got harder he realised that managing time was important and for this to be effective he had to make a timetable. Helen, although she frequently commented on lack of time, did not plan ahead because she gave priority to other events in her life. Neil planned his study time carefully but said he did not use the planning activities. Usha said she didn't need to plan because she had plenty of time available.

Handbook activities

The Handbook sheets were designed to encourage students to describe concepts and terms in their own words. Anna found these helpful at the beginning of the course but soon concentrated on her own method of taking notes that seemed to serve a very similar purpose. David used them at the beginning but even then wrote very short answers. Helen also used them at the start because they were similar to the type of notes she had used for previous study. Neil used the handbook sheets for the first two or three units but then stopped. Usha, however, was very positive about the handbook activities and kept them up throughout the course as she found the process to be very effective in helping her to learn.

Self-assessment activities

None of the students were comfortable with these. Anna said she didn't know what was required of her, David and Helen thought the questions were too personal and Usha said she didn't do things like reflecting on progress. Neil said he didn't do the activities but made his own judgements on his progress based on how up-to-date he was with the suggested timetable for the course.

Comments

Lockwood's study (1995) found that if students saw the benefits of the learning activities, they did them. This seemed to be true for the students in my study. For example Usha used the handbook activities and Anna the planning ones. The students found it easier to see the benefits of the *mathematical* activities (as opposed to the 'learning to learn' ones) as these helped them with their mathematical knowledge and skills and also with assignments. There was a tendency not to recognise or understand the benefits of the 'learning to learn' activities. Sometimes the students were not prepared to give up what they described as valuable study time to do them. There were occasions when students reported making choices about which of the activities would be useful for them. Sometimes their reasons may have been negative ones, for example, not knowing what was expected of them, or lack of time or even reluctance to answering what they regarded as 'personal' questions. In other cases there were indications that, in making selections, students were moving from 'guided' to 'independent' learning, for example Anna's 'revision notes'.

Hodgkinson's study (1999) found that *Open Mathematics* students had mixed reactions to the learning activities. Most of them found them useful to some extent but others saw them as a waste of time or didn't like them even though they saw their value. The study also

showed that some students, like David with the planning activities, initially thought the learning activities were not helpful but realised their usefulness as the course progressed.

4. Do *Open Mathematics* students use reflective type learning?

Anna did not use th word 'reflection' until I had introduced it but in the third interview, when she read the explicit statements about reflection, she said that not only was reflection a good idea but that it was necessary. Although she did not give me a definition of reflection, from her responses to my questions it would seem that she did use the stages of thinking, reviewing and, to some extent, generalising and applying, described as 'reflection' in Unit 16 (Open University 1996c).

David said that by the end of the course he didn't have time to reflect but he also said he found 'reflection coming through the whole study period'. He gave several examples, some of them inconsistent and some of them in general terms rather than a description of what *he* did. It would seem that he used reflection in his own way, when *he* wanted to do it and not when he was asked to as part of the course. David's somewhat painful experiences of overcoming his 'psychological blocks' would seem to fit Boud's assertion that the process of reflection involves feelings (Boud *et al* 1985).

Helen said that the 'reflecting bits' were a waste of time and she was not prepared to share her personal thoughts. She seemed to connect reflection solely with self-assessment of progress rather than as a way of improving her learning.

Neil did not use the word reflection at all and at one point, after I had introduced it, he asked what it meant. He did however refer to 'revision' in terms of preparing for assessment.

Usha at first said she did not do things like reflecting on progress because she didn't know how to do it. Later it emerged that her understanding of reflecting was looking back at work in a passive way rather than an active one of reviewing and planning. However in terms of the processes described in Unit 16 (Open University 1996c), Usha described occasions when she not only thought about her work, but she also identified what she had learned and applied some of her learning experiences to new situations, including work.

Comments

Most of the students seemed to use 'reflection' with one of its everyday meanings, of thinking or musing, looking back passively. In *Open Mathematics* stress is laid on active learning using a cycle of thinking, identifying, generalising and applying. Perhaps it is difficult to undertake these processes as a new student in higher education and also with the added handicap of working in isolation as distance learners often have to do. For me, reflection is easier to apply to my own practice as a tutor than to improving my learning. Though the learning activities in *Open Mathematics* were designed to be integral parts of the course, most of the students in this study did not see them this way and tended to separate out the mathematics from the learning. For Anna and Neil their current methods of learning were sufficient to take them safely through *Open Mathematics* and indeed beyond. Helen's previously learned strategies of learning may not have been sufficient for her to move on to a post-level 1 course successfully, though the reasons she gave for discontinuing her studies were personal ones. David's ability to face and cope with difficulties may indicate that he used a form of reflective learning to identify these and actively find ways of overcoming them. Usha may have used elements of reflective learning though she herself did not use that term.

Other findings

Most of this chapter has been used for a discussion of the students' responses to the four original research questions. The individual stories also include other findings that relate to a particular student. There were other issues that were raised to some degree by all the students so I report here on two that I found interesting; first, the use students made of the graphics calculator in their jobs and second, the differences in usage of the language of learning.

Use of course calculator during and after *Open Mathematics*

All the students referred to the course calculator in relation to their learning at least once during the interviews although I did not ask direct questions about it. Helen found that the operation of the calculator masked her learning of the mathematics whereas Usha found that using the calculator increased her understanding of the statistics which proved useful for her job. In general four of the students appreciated the benefits of the calculator, a result found by Hennessy *et al.* (2001). David was the only one who had a real objection to the calculator though this was one of the 'blocks' he managed to overcome.

An unexpected finding was that four of the students used the calculator for work purposes. Anna used it to collect and analyse data, Neil wrote programs to calculate stress loads, Helen used it to calculate costings and Usha wrote programs for testing equipment. Quite independently of the requirements of the course these students showed that they could apply some of the mathematics learned in *Open Mathematics* to another context.

Language of learning

I was struck by a comment made by Mary Thorpe at an Open University seminar in April 1996 when she said *'People don't have a language for learning about their own learning'*. I came to realise that this may well have been true for the students in my study but I also

found that they had their own language and their meanings were not always shared by me as the interviewer. For example Anna used 'revision' in a different way from me and David initially equated 'learning' with 'remembering'. The issue of confusion between the terms 'studying' and 'learning' was raised earlier in this chapter. This confusion may not have been helped by the fact that the 'learning activities' in *Open Mathematics* might have been called 'study skills' elsewhere.

On the few occasions when the word 'reflection' was used by the students each one tended to use it in a slightly different way though usually in a passive rather than an active sense. Moon (1999) suggests that the use of the prefix 're-' in reflection implies a secondary action, in the sense of returning to previously learned work. As I was transcribing the interview tapes I was struck by the number of different words beginning with 're-' that the students used to describe aspects of their learning. They are listed in alphabetical order in Appendix E. Almost all were used first by one or more of the students during the interview discussions with just five being introduced by me as the interviewer. Some of these words, for example 'regurgitate' describe surface learning (Entwistle 1997). However many of them indicate not just a return to initial learning but words such as 'register' and 'reinforce' suggest a degree of upgrading of learning, what Moon (1999) describes as a stage in reflective learning.

Finally

The five students presented a variety of experiences and attitudes providing rich data for analysis and many issues for further exploration. The seven students in the pilot study provided even more conceptions of learning for consideration, though these are not reported here. I would conjecture that interviewing further students about their learning would produce even more topics and ideas. This variety of experiences would have

delighted my first supervisor for this study, the late Christine Shiu, who as course chair of *Using Mathematics* MST121and *Exploring Mathematics* MS221, expressed an interest in the range of possible positions and motivations of students.

CHAPTER 9 FINAL REFLECTIONS

In this chapter I reflect on what I have learned about research methods, how I might have done things differently and what could be developed in the future. I also suggest ways of using the findings of this study with students, tutors and course writers.

Reflections on my methods

In this section I reflect on what I have learned from this study as a researcher. My reflections on what I learned from the students that have been useful to me as a tutor are included in the individual stories.

As I analysed the transcripts I became acutely aware of their limitations. Partly this was due to the difference in 'oral discourse and written text' (Kvale 1996 page 38). Although to some extent I could still 'hear' the voices of the students as I did the analysis, the transcripts themselves lacked expression and life. I am also aware that the learning experiences, related to me in an oral interview/discussion, could be very different from those the students might produce in written form, especially if the latter were done for assessment purposes.

As a tutor I evaluate and comment on learning for my own students and there are opportunities for feedback, discussion and challenges (which I welcome!). I found the change of role, from tutor to researcher, to be uncomfortable. This made the 'accounting for' sections difficult to write as, unlike tutor comments, they are not intended for the students, whereas the immediate audience for this study will be different.

I have learned that it is easy to fall into the trap of categorising and labelling students or over-stressing certain aspects of their learning stories. Having collected a large amount of data from a total of fifteen interviews in the main study I had to select topics to explore. I

know others might have chosen different ones from the same data but I hope the resonance sections will help to explain my choices.

The original research question about reflective learning turned out to be too ambitious. Anna and Helen did not use the term, Neil and Usha said they didn't know what it meant and David used it in his own way with a different meaning from that in the *Open Mathematics* course materials. This was just one example of my use of a term being different from a student's, an issue discussed in the previous chapter. I realise that I did not always take up opportunities to explore the meanings of words the students used to describe their learning.

During the course of this study I have learned about other researchers' work on students' perceptions of learning, some of it too late to incorporate into my own work. For example Lockwood's study (1995) on perceived benefits provided by activities would have been a useful background for exploring the students' practices of balancing the benefits of these activities against costs such as the study time used.

In preparing for the interviews my questions might have been more structured and focused with probes more consistently applied. After I had completed the interviews I discovered the set of questions used by Morgan, Gibbs and Taylor (1981) and listed in Morgan (1993 p.59). In particular their question 'What is involved when you come to learn something?' might have been useful in eliciting conceptions of the processes of learning rather than descriptions of study skills. As a result of using such questions with adult students, Marton and Säljö (1997 p.55) give six qualitatively different conceptions of learning which might be useful for analysing my own data. The conceptions range from 'a quantitative increase in knowledge' to 'developing as a person'.

However, this would have been an ambitious framework for me to use and is perhaps better suited to a longitudinal study such as that carried out with Open University students over a period of six years by Morgan and Beaty (1997) who showed that students developed their understanding of learning over time

In retrospect, my own questions seem somewhat abstract and were about learning in general rather than learning mathematics. It might have been more useful to ask the students to answer some questions with reference to particular mathematical concepts of their own choosing. There were times when the student *did* illustrate their response with a specific example of mathematics from the course units but I might have encouraged them to do this more often.

With more time I could have used the results of responses in the third interviews to the M, S and R statements (see Appendices B, C and D) for additional analysis and confirmation of what students had said in previous interviews. With more expertise it might have been possible to tackle changes in confidence and use of language as the sequence of three interviews progressed. Having looked again at Kelly's personal construct theory (1955) and the use of repertory grids I feel more confident about using them, though I think it might be easier to apply this method if I was working in collaboration with another researcher with opportunities for discussion.

What could be developed

My study was not designed to explore students' use of the course graphics calculator but all five students referred to it at some point in relation to their learning. The conflicting notions that the calculator masked the mathematics (Helen) and that using the calculator revealed the mathematics (Usha) may be worth investigating further and could continue the

work of Hennessy, Fung and Scanlon (2001). The unexpected finding that four of the five students used the calculator at work after the end of the course could make the basis of an interesting research project, perhaps linking it to the ability to apply techniques and principles learned during *Open Mathematics* to new situations.

Learning vocabulary

As has been discussed in the previous chapter, it was clear that the *Open Mathematics* students interviewed in this study did not always share their vocabulary of learning with me as researcher. I would suggest that a student's vocabulary would differ from that of the writers of the course materials, their tutor and even that of other students. The words listed in Appendix E, such as *review, revision, recall, re-visit, refresh, repeat and re-read*, that were introduced by the students, could form the basis for closer analysis or be a starting point for further research in students' use of the language of learning.

Openings students

I have also worked as a tutor for students on the level 0 access type course *Openings*. For this course, all the tutorials are carried out by telephone and students are expected to discuss their learning and how it can be improved. A similar study to this one could be carried out to discover their conceptions of learning at the start of the course and awareness of any changes in their learning as the course progressed.

What this study could be used for

The title 'Adult mathematics students: reflections on their learning' indicates that students were asked to reflect on their learning; an appropriate activity for students on a course that actively encourages reflective learning. In turn, I reflected on their responses and looked at relevant research on some of the issues raised. References to some of this research are included in the stories.

My purpose in doing this study was to find out more about students' conceptions of learning in order to improve my practice as a tutor. As a result of the series of three interviews I have found out far more about the conceptions of learning held by students than would have been possible with my own *Open Mathematics* students. It has given me the confidence to discuss ideas about learning more explicitly with my students and reminded me that by listening to their ideas I am in a better position to be able to help them.

The issues and topics raised in this study could be developed for use with the various groups involved in Open University courses: students, course designers and writers, and associate lecturers (tutors).

Students, especially those who are new to higher education, need to know they are not alone in facing various issues and that preconceptions of learning may need to change for successful study at a deeper level.

Course designers and writers are aware to an extent of students' conceptions of learning but the diverse stories told in this study with only five students may extend their awareness and reveal new issues to take into consideration in course production.

However this study may be of most use to other tutors, not just those who tutor on *Open Mathematics*, but those who work with students where their last experience of formal learning was at school. Some of the stories illustrate reluctance to change ways of learning or not realising that change might be needed. The issue of trying to achieve a shared language for learning seems to me to be very important but to do this tutors need to start by listening to students and then mediate vocabulary usage. The preparatory materials for *Open Mathematics* (Open University 1995) included a section showing the precise mathematical meanings of words such as 'product' that might have several meanings in

everyday English. A similar consideration of the meanings of terms used to describe learning might be included at various stages of the course, not just at the start.

I have found it very helpful to explore the research literature relevant to issues raised in this study. Other tutors may find these references useful too and they could be made into a collection that could be easily available to tutors, perhaps by a web-site. Finally, I hope that other tutors might be encouraged to undertake their own practitioner research projects and thus add to the body of knowledge about students learning and extend the variety revealed by this study.

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APPENDIX A COURSE DESCRIPTION FOR MU120 OPEN MATHEMATICS (2003 VERSION)

Level: 1 Points: 30

No computer required No residential school

Summary

This course should build your confidence and help you to incorporate mathematical thinking into your everyday life. It looks mathematically at matters of general interest including prices, earnings, health, music, art, maps, motion and rainbows. Alongside mathematical skills, it aims to help you develop communication and learning skills. You will cover statistical, graphical, algebraic, trigonometric and numerical concepts and techniques, an introduction to iteration, mathematical modelling, and the interpretation of slopes of graphs. Formal calculus is not included. Throughout the course you will also learn how to use a graphics calculator (you will be told how to obtain the recommended model).

Description

This course should help you to integrate mathematical thinking into your everyday thinking as part of your common sense, and build up your confidence in using and learning mathematics and in studying at a distance. It is about the relationship between mathematics and the world in general, and assumes only the skills that most numerate and literate adults use in their everyday lives. You are not expected to have any algebraic skills.

The course will be of interest to students with a variety of concerns and study plans. It offers an introduction to mathematics and its uses that is of interest in itself, even if you undertake no further study or use of mathematics (though we hope that by the end of the course you'll find mathematics so fascinating that you'll want more). The skills it introduces will be valuable to those who intend to specialize in mathematics courses, even if they have met some of the mathematical concepts and techniques before. It is also suitable for all those who will be users of mathematics in other areas, such as computing, science, technology, social science, humanities or education.

The course looks mathematically at a variety of fields, indicated by the titles of study texts below, and examines general questions such as whether people are becoming better off in relation to income and prices. Among the mathematical ideas are statistical, graphical, algebraic, trigonometric, iterative and numerical concepts and techniques. It also introduces mathematical modelling and looks at the interpretation of slopes or gradients of graphs, but leaves formal calculus techniques to the next Level 1 course, MST121 Using mathematics. Although there is some overlap with the topics taught for GCSE and A-level, the approach is very different. You will be interpreting your mathematical results in context and explaining the relevant concepts at a level appropriate to Higher Education. Throughout the course you will learn how to use the TI-83 graphics calculator. Alongside

mathematical skills, the course should also help you to develop your communication and learning skills. These key skills are readily transferable to other subject areas.

It will take you one to two weeks to work through each study text. The titles are *Mathematics everywhere, Prices, Earnings, Health, Seabirds, Maps, Graphs, Symbols, Music, Predictions, Movement, Growth and decay, Baker's dozen, Space and shape, Repeating patterns, Rainbow's end.*

The amount of time you need to spend studying the course is likely to depend on your previous experience. For example, if you have not previously met any of the concepts covered by the course, and/or have no recent experience of studying, then you should expect to spend substantially more than the eight hours per week taken by an average student. Alternatively, if you have studied recently and are familiar with some of the mathematics in the course, you may need less time.

Entry

This course is part of the mathematics entry suite, leading to MST121 *Using mathematics* and MS221 *Exploring mathematics*. Your choice of which of the three to take depends on how much mathematical knowledge you already have and on the degree you have in mind. If you are not confident with algebra and trigonometry (through gaining a good pass in the highest-level GCSE mathematics, for example), you should start with MU120. You could then go on to MST121. For advice about which course to take, please ask your Regional Centre for the leaflet Maths Choices, or look at the website:

Level 1 courses provide core subject knowledge and study skills needed for both higher education and distance learning, to help you progress to courses at Level 2. If you have any doubt about the level of study, please seek advice from your Regional Centre.

What's included

Course books, television programmes, audio cassettes, video cassettes.

You will need

Television, audio and video cassette players. If you register for the course we will tell you how to order the #TI-83Plus graphics calculator,

Support from your tutor

You will have a tutor who will help you with the course material and mark and comment on your written work, and whom you can ask for advice and guidance. If you are new to the OU, you will find that your tutor is particularly concerned to help you with your study methods. We may also be able to offer local group tutorials or day schools that you are encouraged, but not obliged, to attend. Where your tutorials are held will depend on the distribution of students taking the course. Ask your Regional Centre if you need to know more before you decide whether to register. Your Regional Centre can provide you with both general and certain specialist help with your studies.

Assessment

There are five tutor-marked assignments, four computer-marked assignments, and an end-of-course assessment; this last consists of a computer-marked assignment and a written assignment that you complete at your usual place of study. (The first tutor-marked assignment and the first computer-marked assignment are associated with the preparatory materials, and your scores for them will not count towards your course result.) Assessment is an essential part of the teaching, so you are expected to complete it all. But if you unavoidably miss or do badly in an assignment, this course allows you a 'substitution score', calculated as a weighted average of all your scores for the course. In MU120 this rule can apply to one tutor-marked assignment and one computer-marked assignment, but not to the end-of-course assessment.

APPENDIX B: M STATEMENTS (FIRST TO BE ASKED) IN INTERVIEW 3

Key: Agree ✓ Disagree ✖ shading = originally stated by

Statement	Code	ANN A	David	Helen	Neil	Usha
I found some of the activities intrusive.	mA	✓		✓		✓
There wasn't enough time to do the Learning File sheets	mB	✓		✓		✖
I found the self-assessment activities hard.	mC	✓			✖	
Having no exam suited me.	mD	✓		✓		✓
I apply the mathematics from MU120 at work now.	mE	✓		✓	✓	
I'm more confident in my mathematics now.	mF	✓		✓	✓	✓
I found the planning sheets useful.	mG	✓	✓	✖		✖
I didn't like the yellow sheets	mH			✓		✓
I found the handbook sheets helpful.	mJ	✓	✓		✖	
The end of course assessment wasn't as bad as I expected.	mK		✖	✓		
I learned how to learn.	mL		✓	✓		✓
I learned how to study.	mM		✓	✓	✖	
I learned how to manage my time.	mN	✓	✓	✓		✓
I learned how to apply maths outside as well as in the course.	mP	✓		✓	✓	✓
Doing the TMAs helped my progress most.	mQ			✓	✓	
I missed most of the learning activities out.	mR		✖	✓		
I used the calculator books a lot.	mS	✓	✓	✓		✓
I felt a lot more confident about using the calculator.	mT			✓	✓	✓
You have to think for yourself in this course (MU120)	mU			✓		

APPENDIX C: S STATEMENTS – (SECOND TO BE ASKED) IN INTERVIEW 3

Key: Agreed strongly with statement ✓ Disagreed strongly with statement ✖

Blank - no views either way Shaded – originally said by

Statement	Code	Anna	David	Helen	Neil	Usha
It's my pet hate, written work.	sA	✖	✖	✓	✓	✓
I find it helpful to discuss problems with other students.	sB	✓	✓	✓	✓	✓
I find it helpful to phone my tutor.	sC	✖		✖		✖
I learn from the answers at the back of the units.	sD			✖ ✳		
I've never, as yet, phoned my tutor with a problem.	sE	✓		✓	✖	✓
Once I write something I feel I can memorise it a bit more.	sF	✓	✓	✓		✓
Explaining it to someone else is quite good.	sG	✖	✓	✓	✓	✓
Making notes helps me to learn.	sH	✓	✓	✓		✓
I learn best when there's a reason for it - when I really want to do it.	sJ	✓	✓		✓	✓
Re-reading something is enough to learn it.	sK	✖			✖	✖
Having understood the work I can sort if out it in my own words.	sL	✓	✓	✓		
Discussing work often clarifies your mind.	sM		✓	✓	✓	✓
My style of learning is learning from experience . . . doing.	sN	✓	✓			
I learn from my mistakes.	sP	✓	✓	✓		✓
When I have to sit down and actually concentrate it goes in deeper.	sQ	✓		✓		✓
If I don't understand something I have to keep going over it all	sR		✓	✓	✓	✖

✳ changed from the original statement 'I never learn from the answers at the back'

APPENDIX D: R STATEMENTS (THIRD TO BE ASKED) IN INTERVIEW 3

Key: Agreed strongly with statement ✓ Disagreed strongly with statement ✖

Blank - no views either way Shaded – originally said by

Statement	Code	Anna	David	Helen	Neil	Usha
Reflecting means looking back over your work.	rA			✖		✖
Reflecting on progress is looking back to see how far you've come.	rB		✓	✖		✓
I make revision notes.	rC	✓		✓	✖	✓
I don't do things like reflecting on progress.	rD	✖	✖	✓	✓	✓
Reviewing is going back through the work and sorting out what the important bits are.	rE	✓	✖		✓	✓
The reflecting bits – I skip them.	rF		✖	✓		✓
If I don't understand something I have to keep going back over it so that it all fits into place before I can move on.	rG	✖		✓		✖
If I don't quite understand something I went back to that chapter. It's just like re-visiting it or revision.	rH	✓		✓		✓
At the end I reviewed because I had to check my work and decide which were the best examples to use. (for the ECA)	rJ	✓	✓	✓		
The reflection is luxury. It's a necessity but a luxury.	rK		✓	✖		✖
For the end of course assessment I wrote it out and reviewed it to see if I'd answered the question.	rL	✓		✓	✓	✓
No-one else sees the reflecting bits so it's not worth spending time on them.	rM	✖	✖	✓		
I didn't do the reflecting bits because they're personal.	rN	✖	✓	✓		✓

APPENDIX E: RE- WORDS CONNECTED WITH LEARNING USED BY OPEN MATHEMATICS STUDENTS

Key: after used by interviewer x

Word	Anna	David	Helen	Neil	Usha	Inter-viewer
Realise	A	D		N		
Recall		D	H			
Recap						I
Recognise	A	D				
Recollect					U	
Record		D	H			
Re-do						I
Refer (back)		D	H			
Reflect	A	Dx	H		Ux	
Refresh	A	D				
Register					U	
Regurgitate					U	
Reinforce				N		
Reject		D				
Relate	A	D			U	
Relearn						I
Rely	A					
Remember	A	D		N	U	
Remind		D				
Reproduce						I
Re-read	A	D	H	N	U	

Word	Anna	David	Helen	Neil	Usha	Inter-viewer
Research					U	
Reserve		D				
Re-sit		D				
Retain		D	H			
Retake			H			
Review	A	D				
Revise	A		H			
Revision	A	D	H	N		
Re-visit				N		
Revive					U	
Re-work		D				
Re-write						I
No of Words used	11	18	9	6	9	5

Unit 1 Activity 12 Describing own learning

First learning example I selected

Second learning example I selected

Unit 1 Activity 13 Approaches to learning

From my description of learning examples,

I am the sort of person who learns well when:

I am the sort of person who does not learn well when:

1.4

Unit 3 Activity 43 Looking back

Prior knowledge I had relating to statistics	*Some examples of what I know now*	*Evidence to demonstrate what I know now (for example, activities completed)*

One topic I have found straightforward

One topic I have found difficult and the action I intend to take

Unit 1 Handbook activity Mathematical terms

Term	*Explanation of term*
x squared	
Square root	
Reciprocal	
Power	
Percentage	